

1 National Transportation Safety Board

2
3 Office of Marine Safety

4 Washington, D.C. 20594

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8 Group Chairman's Factual Report

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13 Survival Factors Group
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19 *El Faro*

20 DCA16MM001

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22 December 9, 2016
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1. ACCIDENT INFORMATION

Vessel:	SS <i>El Faro</i>
Accident Number:	DCA16MM001
Date:	October 1, 2015
Time:	0739 eastern daylight time (EDT)
Location:	North Atlantic Ocean, 40 nautical miles northeast of Acklins and Crooked Islands. Bahamas 23.3925° N, 73.9029° W
Accident type:	Sinking
Complement:	27 crew, 6 supernumeraries

2. SURVIVAL FACTORS GROUP

Chairman	R. Jon Furukawa Office of Marine Safety National Transportation Safety Board Washington, DC 20594
Member – U.S. Coast Guard	Paul A. Webb Search and Rescue Program Manager, District 17 Juneau, Alaska 99801
Member – TOTE Services, Inc.	Patricia Finsterbusch Assistant Manager Safety & Operations Jacksonville, Florida 32256
Member – ABS	Louis O'Donnell Assistant Chief Surveyor – Americas Houston, Texas 77060
Member – Harding Safety USA (Palfinger)	Tio Devaney Operations Director – North America Pompano Beach, Florida 33073

3. SUMMARY

On Thursday, October 1, 2015, about 0715 EDT, the US Coast Guard received distress alerts from the 790-foot roll-on/roll-off container (Ro/Con) ship *El Faro*. The US-flagged ship, owned by TOTE

1 Maritime Puerto Rico (formerly Sea Star Line, LLC¹) and operated by TOTE Services, Inc. (TOTE), was
2 40 nautical miles (nm) northeast of Acklins and Crooked Islands, Bahamas, and close to the eye of
3 Hurricane Joaquin. The ship was en route from Jacksonville, Florida, to San Juan, Puerto Rico, with a
4 cargo of containers and vehicles. Just minutes before the distress alerts were received, the *El Faro* captain
5 had called TOTE's designated person ashore and reported that a scuttle had popped open on deck two and
6 that there was free communication of water into the No. 3 hold. He said the crew had controlled the ingress
7 of water but that the ship was listing 15° and had lost propulsion. The Coast Guard and TOTE were unable
8 to reestablish communication with the ship. Twenty-eight US crewmembers, including an off-duty
9 engineering officer sailing as a supernumerary, and five Polish workers were on board. The vessel sank
10 in 15,400 feet of water.

11 The Coast Guard, US Navy, and US Air Force dispatched multiple assets to the ship's last known
12 position, but the search was hampered by hurricane-force conditions on scene. On Sunday, October 4, a
13 damaged lifeboat and two damaged liferafts were located. The same day, the Coast Guard found a
14 deceased crewmember wearing an immersion suit. A Coast Guard rescue swimmer tagged the body in the
15 immersion suit and left to investigate reported signs of life elsewhere but then could not relocate the tagged
16 suit. No signs of life were found, and on Monday, October 5, a debris field and oil slick were discovered.
17 The Coast Guard determined that *El Faro* was lost and declared the event a major marine casualty. The
18 Coast Guard suspended the unsuccessful search for survivors at sundown on Wednesday, October 7.

¹ On September 17, 2015, the parent company, TOTE, Inc., announced that Sea Star Line had been renamed TOTE Maritime Puerto Rico.

4. INJURIES

Type of Injury	Crew	Supernumeraries	Total
Fatal	27	6	33
Serious	0	0	0
Minor	0	0	0
None	0	0	0
Total	27	6	33
Title 49 <i>Code of Federal Regulations</i> (CFR) section 830.2 defines a fatal injury as any injury that results in death within 30 days of an accident. It defines serious injury as that which requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; results in a fracture of any bone (except simple fractures of fingers, toes, or nose); causes severe hemorrhages, nerve, muscle, or tendon damage; involves any internal organ; or involves second- or third- degree burns, or any burn affecting more than 5 percent of the body surface.			

5. DETAILS OF INVESTIGATION

5.1. Launch and On-Scene Investigation

The National Transportation Safety Board (NTSB) learned of the missing ship from a Coast Guard email sent at 1605 on October 1, 2015. The accident became a major marine casualty when Coast Guard District 7 in Miami, Florida, announced at a 1000 press conference on October 5 that *El Faro* had sunk. At that point, the search and rescue (SAR) effort changed exclusively to lifeboats, liferafts, and persons in the water. A team of five investigators, a board member, and support staff launched from NTSB headquarters on October 6 and arrived on scene in Jacksonville later the same day. The investigation was led by the NTSB. Parties to the investigation were the Coast Guard, TOTE, the American Bureau of Shipping (ABS), and the National Weather Service. The on-scene portion of the investigation was completed on October 15. On October 31, a Navy ship fitted with underwater detection equipment located the wreckage of *El Faro* at a depth of about 15,400 feet.

After the initial launch, the fact-gathering phase of the survival factors investigation included follow-on interviews in Miami; Jacksonville; Norfolk, Virginia; Arlington, Virginia; Washington, DC; Wilmington, Delaware; and by phone. The Coast Guard convened Marine Board of Investigation (MBI) hearings in Jacksonville in February and May 2016. The NTSB participated in the hearings. In April 2016, a research vessel from the National Science Foundation and Woods Hole Oceanographic Institution traveled to the accident site and located *El Faro*'s voyage data recorder (VDR) but could not retrieve it. In August 2016, the Navy ship revisited the site and on August 8, recovered the VDR capsule, which yielded 26 hours of data.

5.2. Vessel Description

Vessel Name	SS <i>El Faro</i>
Owner/Operator	TOTE Maritime Puerto Rico/TOTE Services, Inc.
Port of Registry	San Juan, Puerto Rico
Flag	United States
Type	Cargo – Ro/Con
Built	1975
Official number	561732
Classification society	American Bureau of Shipping
Construction	Steel, reduced scantlings
Draft	30 feet (9.1 meters)
Length	790 feet (240.8 meters)
Beam	105 feet (32.0 meters)
Gross/Net tonnage	31,515 / 21,473
Engine power and type	Steam turbine, 30,000 shaft HP, single screw
Service speed	20 knots
Cargo	Containers and rolling cargo
Persons on board	33
Fatalities	33
Damage cost	Estimated \$36 million

5.3. Search and Rescue Narrative

Hurricane Joaquin

Hurricane Joaquin was classified as a Category 4 hurricane (winds of 113 to 136 knots) by the National Hurricane Center, a division of the National Weather Service, which in turn is part of the National Oceanic and Atmospheric Administration (NOAA). Joaquin was the strongest October hurricane known to have affected the Bahamas since 1866.² For a detailed description of the hurricane's history through the time of the *El Faro* sinking on October 1 and the forecasting efforts of the National Hurricane Center, see the factual report of the NTSB's Meteorology Group.

Joaquin became a major hurricane (winds 96-112 knots) on October 1 (figure 1 shows the forecast conditions for October 1) and reached maximum sustained winds of a Category 4 hurricane on October 2. Joaquin made landfall on several islands of the Bahamas—first on Samana Cay on October 1, then on Rum Cay and San Salvador on October 2. In addition, Joaquin's eyewall moved over Crooked Island, Long Cay, and Long Island. On October 3, the hurricane accelerated northeastward away from the Bahamas and reintensified, reaching a peak intensity around 135 knots, just below Category 5 strength.

² R. Berg, *National Hurricane Center Tropical Cyclone Report, Hurricane Joaquin, 28 September–7 October 2015*, report AL112015 (National Hurricane Center, January 12, 2016), p. 1.

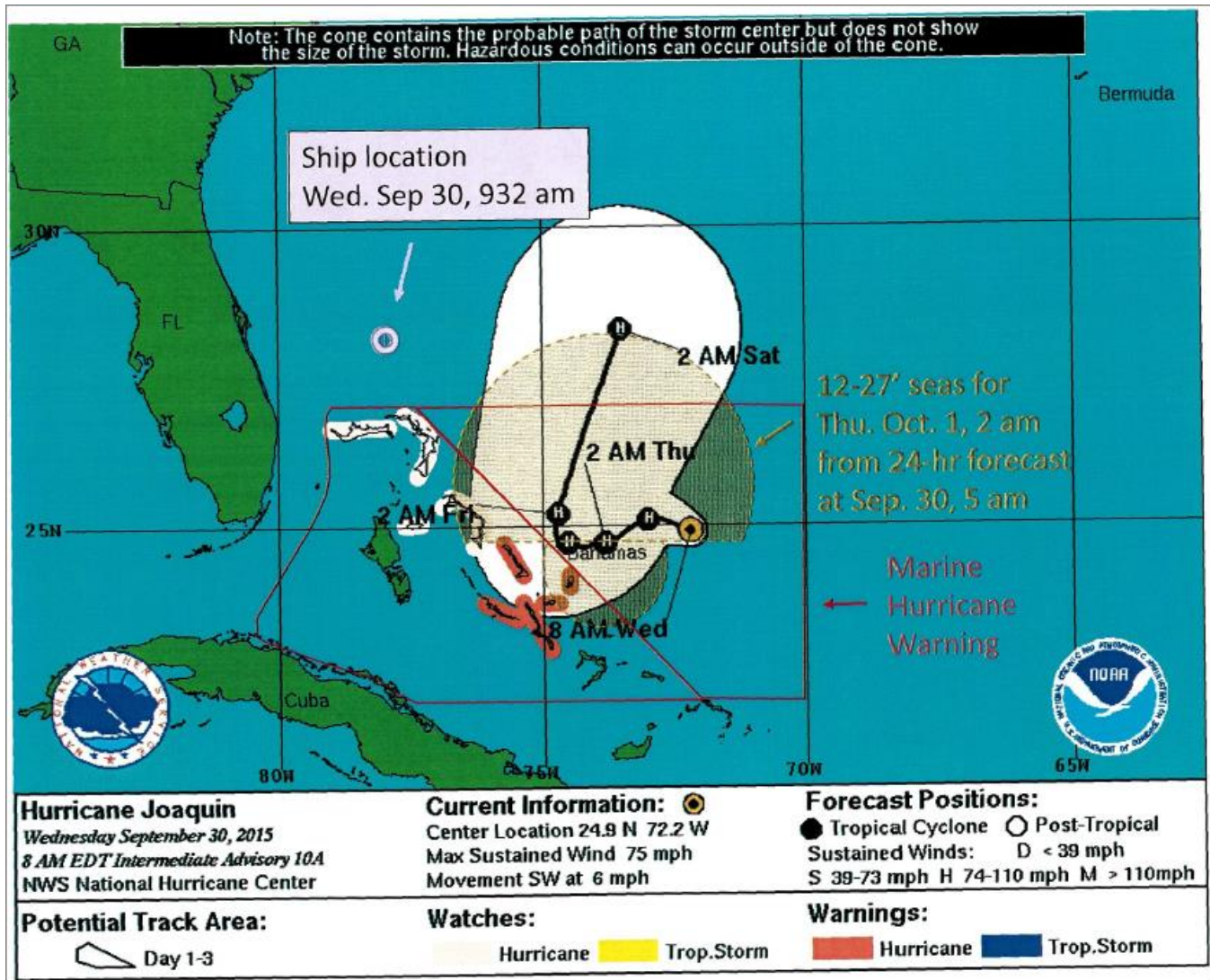


Figure 1. National Hurricane Center, Hurricane Joaquin Intermediate Advisory 10A, showing *El Faro*'s location on September 30 and forecast conditions for October 1, with hurricane warning area and 12-foot sea radii approximated.

Joaquin lost its status as a major hurricane on October 4 and moved north-northeastward over the western Atlantic on October 4 and 5. Weakening continued, but Joaquin's intensity stabilized near 75 knots for about a day. The hurricane turned northeastward and east-northeastward on October 6 and 7. The hurricane weakened to a tropical storm on October 7.³

³ R. Berg, *National Hurricane Center Tropical Cyclone Report Hurricane Joaquin, 28 September – 7 October 2015*, report AL112015 (National Hurricane Center, January 12, 2016), pp. 2-5, tables 1 and 8, figures 1 and 2.

SAR Day 1: Thursday October 1, 2015

On the morning of October 1, while *El Faro* was passing northeast of Acklins and Crooked Islands,⁴ the captain called the TOTE designated person ashore (DPA)⁵ at 0659 EDT via INMARSAT and left a 35-second voicemail message:

*This is Captain *****, Thursday morning, 0700. We have a navigational incident. Um, I'll keep it short. A, uh, scuttle popped open on 2-deck and we were having some free communication of water go down the 3 -- 3-hold. Have a pretty good list. I want to, uh, just touch --contact you verbally here. Everybody's safe. Um, uh, but I want to talk to you.*⁶

After leaving the voicemail, the captain called TOTE's contracted emergency call center (AMAC Commercial Call Center) at about 0702 for assistance in reaching the DPA. The call center recorded a conversation between the captain and the call center's operator in which the captain described his situation (see Table 1).⁷

Table 1. *El Faro* captain's conversation with call center operator, October 1.

Time	Person	Statement
0702:14	Operator	<i>Okay sir.</i>
0702:20	Captain	<i>Are you connecting me through to a QP?</i>
	Operator	<i>That's what I'm getting ready now. We're seeing who is on call and I'm going to get your right to them give me one second sir, I'm going to put</i>

⁴ This SAR section was compiled from Coast Guard Marine Information for Safety and Law Enforcement (MISLE) case 996189 initial notification with 23 updates, the TOTE incident command center log, and Coast Guard "*El Faro* Next of Kin" PowerPoint presentation, October 7, 2015.

⁵ "To ensure the safe operation of each ship and to provide a link between the Company and those on board, every Company, as appropriate, should designate a person or persons ashore having direct access to the highest level of management. The responsibility and authority of the designated person or persons should include monitoring the safety and pollution prevention aspects of the operation of each ship and ensuring that adequate resources and shore-based support are applied, as required" (section 4, p. 13, in International Safety Management Code, 3rd Edition, International Maritime Organization, London, 2010).

⁶ DPA, TOTE interview transcript and errata, October 7, 2015, pp. 8-9.

⁷ Coast Guard MBI exhibits 29 and 30: a single recorded phone conversation of 3 minutes, 5 seconds between the AMAC Commercial Call Center operator and the *El Faro* captain on the morning of October 1, 2015, about 0702; and MBI transcripts of February 20, 2016, pp. 74-76.

Time	Person	Statement
		<i>you on a quick hold. So one moment please. Okay, sir. I just need your name please.</i>
0702:42	Captain	<i>Yes, ma'am, my name is *****.</i>
0702:51	Operator	<i>Your rank?</i>
0702:55	Captain	<i>Ship's master.</i>
0703:02	Operator	<i>Okay thank you. Ship's name?</i>
0703:05	Captain	<i>El Faro</i>
0703:07	Operator	<i>Spell that E-L.</i>
0703:11	Captain	<i>Oh man, the clock is ticking can I please speak to a QI? El Faro, E-L F-A-R-O, El Faro.</i>
0703:29	Operator	<i>Okay and in case I lose you what is your phone number please.</i>
0703:38	Captain	<i>Phone number 870-773-206528.</i>
0703:52	Operator	<i>Got it.</i>
0703:55	Captain	<i>That's my globe and let me give you my mini M. Ready to copy?</i>
0704:00	Operator	<i>Yes.</i>
0704:03	Captain	<i>870-764-667272</i>
0704:14	Operator	<i>Got it sir. Again I'm going to get you reached right now, one moment please.</i>
0704:19	Captain	<i>And Mate what else to do you see down there? What else do you see?</i>
2nd Audio 0704:25	Operator	<i>I'm going to connect you now okay. Hi good morning my name is ***** (talking to DPA). Just give me one moment I'm going to try to connect you now. Okay. Mr. *****?</i>
0704:35	Captain	<i>Okay.</i>
0704:36	Operator	<i>Okay, one moment please. Thank you for waiting.</i>
0704:38	Captain	<i>Oh God.</i>
0704:39	Operator	<i>Just briefly what is your problem you're having?</i>
0704:55	Captain	<i>I have a marine emergency and I would like to speak to a QI. We had a hull breach, a scuttle blew open during a storm we have water down in 3 hold with a heavy list. We've lost the main propulsion unit; the engineers cannot get it going. Can I speak to a QI please?</i>
0705:05	Operator	<i>Yes, thank you so much, one moment.</i>
End		

^aQI = qualified individual, was the same person designated as the DPA. As specified at 33 CFR 155.1026, the response plan must identify a qualified individual and at least one alternate who meet the requirements of the section. The qualified individual or alternate qualified individual must be available on a 24-hour basis.

About 0706 EDT, the call center connected *El Faro*'s captain to the DPA in an unrecorded conversation. According to the DPA, the captain reported that there was a "secured source of water," that a scuttle was blown open, and that the No. 3 hold had a "considerable amount" of water in it. The ship

was listing to port, with no main engine. The DPA stated that the captain reported the vessel's position as 23° 26.3'N, 073° 51.6'W.

The DPA heard the captain ask a mate for the position relative to land—a female voice could be heard reporting 48 miles east of San Salvador. The captain continued, saying they were pumping water out of the hold, that there was no panic, and that the crew did not plan on leaving the ship. The captain reported the ship was in 10- to 12-foot northeast swells⁸ and high winds, and was listing 15°. The captain wanted to let the DPA know of the ship's condition before he ordered all the emergency alarm buttons activated.⁹

At 0724 EDT, the DPA, according to company protocol, called the Coast Guard Atlantic Area (LANTAREA) command center in Norfolk, Virginia, which was acting as the international maritime rescue coordination center (MRCC). At 0738, the SAR operations unit (OU) watchstander at Coast Guard Seventh District Command Center (D7CC) in Miami, acting as the regional rescue coordination center (RCC), called the DPA on his cell phone (see Table 2).¹⁰

Table 2. Phone call from D7CC SAR watchstander to TOTE DPA.

Time	Person	Statement
0738:06	DPA	*****.
0738:08	SAR watchstander	<i>Hey **** this is Petty Officer ***** I'm from the Coast Guard in Miami, Florida. How are you?</i>
0738:12	DPA	<i>Yes, sir.</i>
0738:13	SAR watchstander	<i>Hey I'm calling you back, you were listed as a POC for the El Faro.</i>
0738:17	DPA	<i>That's correct.</i>

⁸ National Hurricane Center director and deputy director interview transcript, errata, and *Rough Analysis of NHC Products and Concurrent El Faro Locations* report, October 14, 2015. NHC Intermediate Advisory 13A (0200 EDT) predicted 30-foot seas and sustained winds at 64 knots, increasing to a maximum of 105 knots as *El Faro* approached the eyewall of the hurricane.

⁹ DPA interview transcript, errata and notes, October 7, 2015, pp. 26-32.

¹⁰ Coast Guard MBI exhibit 31: recorded phone conversation between D7CC and the DPA on the morning of October 1, 2015, at approximately 0738, lasting 4 minutes, 46 seconds; and MBI transcripts of February 20, 2016, pp. 84-86.

Time	Person	Statement
0738:18	SAR watchstander	<i>Okay, do you have contact or direct communication with the vessel?</i>
0738:21	DPA	<i>I did they called me I was just actually trying to call them back, and I couldn't the satellite is dropping the call. I can give you the phone number.</i>
0738:29	SAR watchstander	<i>Yeah give me the phone number for the vessel that's fine.</i>
0738:32	DPA	<i>The satellite number, you have to dial 011 first to get the satellite. 870-773-206528.</i>
0738:53	SAR watchstander	<i>Okay, I'm going to repeat that back. 011-870-773-206528.</i>
0739:02	DPA	<i>That's correct, that's what they called me on. I tried calling them back a few minutes ago to see if they had any contact with you guys yet. They have?</i>
0739:12	SAR watchstander	<i>We contacted – they've contacted LANT Area.</i>
0739:17	DPA	<i>Yeah, RCC Norfolk I talked to them and they said they were going to notify you. Can you tell me what the plan, what you planning on doing now? You said you were going to contact the Bahamas I guess?</i>
0739:31	SAR watchstander	<i>Well yes, sir. So here's the deal and that depends. So right now, right now based on all the information you've provided me, you know I'm not in the distress phase currently, because - ---</i>
0739:46	DPA	<i>Okay.</i>
0739:47	SAR watchstander	<i>Because they're not at risk of sinking and they have dewatered and they uh – they're without power and engines.</i>
0739:55	DPA	<i>Correct.</i>
0739:56	SAR watchstander	<i>Are they – so are they able to anchor that boat right there?</i>
0740:00	DPA	<i>Uh I don't think, they're 48 miles East of San Salvador, so I don't think so.</i>
0740:09	SAR watchstander	<i>Yeah. Well the position I'm looking at they should be able to anchor.</i>
0740:13	DPA	<i>Oh really, okay.</i>
0740:14	SAR watchstander	<i>It's not that deep and there's some small Islands that they're right near. So I'm trying to ----</i>
0740:22	DPA	<i>Yeah you've got a better map than me right now. I'm sorry your last name is?</i>
0740:32	SAR watchstander	<i>*****. And right now I am going to pass this information on to the Bahamas. And you know it just depends because this is a large motor vessel.</i>
0740:45	DPA	<i>Right.</i>
0740:46	SAR watchstander	<i>So generally for these types of situations where there's not like an emergency distress where we would need to go out there and remove people from the vessel or something like that.</i>
0740:57	DPA	<i>Correct.</i>

Time	Person	Statement
0740:58	SAR watchstander	<i>If they are just disabled, then generally it would be up to the company to provide some type of tug assist or something else like that.</i>
0741:07	DPA	<i>Okay.</i>
0741:09	SAR watchstander	<i>Have you guys, like do you guys have like commercial towing assistance or any type of salvage contracts in place already?</i>
0741:17	DPA	<i>Yes. Yes, we do. And I can contact them.</i>
0741:22	SAR watchstander	<i>I would say to contact them sooner rather than later.</i>
0741:26	DPA	<i>Okay.</i>
0741:27	SAR watchstander	<i>Because you know, obviously I'm going to call the ship and try to get a better deal of what the situation is. But from what was passed on to me right now we would be -- we would generally go that route.</i>
0741:42	DPA	<i>Okay, no that makes sense.</i>
0741:44	SAR watchstander	<i>If you're in a territorial seas of foreign countries as well. So I'm looking --</i>
0741:48	DPA	<i>Right.</i>
0741:49	SAR watchstander	<i>I'm looking right now. Your nearest probably safe haven where they could pull in is Turks and Caicos.</i>
0742:04	DPA	<i>Okay.</i>
0742:08	SAR watchstander	<i>All right. And I will give you a call back with updates. Are you going to be the point of contact through this case with me?</i>
0742:15	DPA	<i>Yes.</i>
0742:16	SAR watchstander	<i>Okay. All right, great. I'm going to try to give the ship a call and get a better handle on what the situation is and what's going on now. And if you hear from them just give me a call back.</i>
0742:27	DPA	<i>And what's your direct number?</i>
0742:29	SAR watchstander	<i>It's 305.</i>
0742:30	DPA	<i>Okay.</i>
0742:31	SAR watchstander	<i>***_****.</i>
0742:36	DPA	<i>Okay, sir.</i>
0742:37	SAR watchstander	<i>Thank you. Bye</i>
End.		

1 **Actions by Company**

2 The DPA set up TOTE's incident command center in Jacksonville on October 1.¹¹ At 0745, the
3 DPA put T&T Marine Salvage company on notice, and at 1342, the ABS rapid response damage
4 assessment (RRDA) group¹² was established at ABS headquarters in Houston, Texas. TOTE and the Coast
5 Guard kept close contact with D7CC, holding conference calls in the morning, evening, and as required
6 during SAR operations. TOTE provided senior company liaison employees to D7CC, and the Coast Guard
7 provided liaison officers from Sector Jacksonville.

8 **Distress Alerts**

9 At 0713 (1113:21 universal coordinated time [UTC]) on October 1, an INMARSAT-C¹³ distress
10 alert was sent by *El Faro* from about 35 miles northeast of Crooked Island (position 23.28N, 073.48W).
11 An INMARSAT-C distress alert is sent by the crew when a ship is in danger. The Global Maritime Distress
12 Safety System (GMDSS) operator on board, typically a ship's officer, can manually input information, or
13 the GMDSS operator can press and hold down a dedicated distress button for about 5 seconds to transmit
14 an alert. When the button is pressed, a short preformatted message is transmitted, with priority, from the
15 ship's terminal to an addressed land earth station (LES) that automatically routes it to an associated
16 MRCC. The distress alert contains information about the terminal's identification, the addressed LES,
17 date and time of alert, ship's details, position, course, speed, time of last position update, nature of distress,

¹¹ TOTE closed its incident command center on Monday, October 12, 2015.

¹² A team of naval architects, marine engineers, master mariners, and support staff that conducts structural and stability calculations for the shipowner. ABS RRDA brochure downloaded at www.eagle.org on September 27, 2016.

¹³ INMARSAT-C (International Maritime Satellite Organization) provides the space segment for maritime safety communications for ships at sea. The INMARSAT space segment consists of four operational geostationary satellites. *Pub. No. 9 The American Practical Navigator Bowditch*, 2002, pp 395-396, National Geospatial-Intelligence Agency, Bethesda, Maryland.

1 and flag. Figure 2 shows the INMARSAT-C distress button on *El Faro*'s sister ship *El Yunque*, which
2 investigators visited after the accident because its layout and equipment were similar to those of the sunken
3 vessel.



4
5 **Figure 2:** INMARSAT-C distress button on *El Faro*'s sister ship *El Yunque*.

6 When an MRCC receives a distress alert, it communicates with the SAR coordinator.¹⁴ In this case,
7 at 0715 (1115 UTC), the LES in Eik, Norway, automatically forwarded the alert to the MMRC in Norfolk.
8 The LANTAREA command duty officer (CDO) sent the alert with the position 23.28N, 073.48W and the
9 position received from the phone call with the DPA (23°26.3'N, 073°51.6'W, 48 nm east of San Salvador),

¹⁴ INMARSAT downloaded August 12, 2016 <http://www.inmarsat.com/services/safety/inmarsat-c/>

1 the position used as *El Faro*'s last known position for the SAR operation. The CDO also called the
2 appropriate RCC, which was D7CC in Miami, to notify the SAR watchstander before he sent an email
3 with additional information about the vessel. The CDO requested D7CC to assume the role of search and
4 rescue mission coordinator (SMC) and work with RCC Bahamas to respond and to keep LANTAREA
5 informed.¹⁵

6 Two automated alerts from *El Faro*'s ship security alert system (SSAS) were sent and
7 automatically forwarded by the LES in Eik, Norway. The first was sent to the Coast Guard at 0715 (1115
8 UTC), with position 23:25.39N, 073:52.51W; time 10/01/2015 11:13:49 (UTC); course 214°, speed 04
9 knots. The second SSAS alert was sent TOTE at 0717 (1117 UTC), with position 23:25.22N, 073:52.68W;
10 time 10/01/2015 11:15:57; course 227°, speed 10 knots.

11 The SSAS is a covert distress signal normally used when a ship is attacked by pirates. It will alert
12 the vessel's company security officer and flag state of the attack without alerting pirates or armed robbers
13 that the ship has sent a distress signal. The SSAS is activated by pressing a dedicated button at the
14 emergency communications station, which then transmits the ship's identity, position, course, and speed.
15 Figure 3 shows the emergency communications station on *El Faro*'s sister ship *El Yunque*.

¹⁵ LANTWATCH email of October 1, 2015, at 0733 to D07-SMB-CMDCENTER, Subject: *Inmarsat C distress: Distress info EL FARO, 48NM East of San Salvador*.



Figure 3. Emergency communications station in starboard aft corner of *El Yunque's* bridge.

At 0736 (1136 UTC) a transmission from *El Faro's* registered emergency position-indicating radio beacon (EPIRB) was detected by geostationary satellite G13 (GOES 13). The hexadecimal code was transmitted to the US Mission Control Center (USMCC) through the local user terminal at the NOAA search and rescue satellite-aided tracking (SARSAT) facility in Suitland, Maryland, after processing and matching the hexadecimal code to *El Faro*. An EPIRB is a float-free, automatically activated device, detectable by satellite anywhere in the world. An EPIRB transmits registration data about the carrying vessel, including the vessel name, type of survival gear, and emergency points of contact ashore. Geostationary satellites can only receive hexadecimal code assigned to the beacon that corresponds to the registration data held by NOAA. Without a global positioning system (GPS)-embedded beacon, geostationary earth orbit (GEO) search and rescue (GEOSAR) alerts will not contain position information.

1 Low-altitude, near-polar-orbiting satellites detect doppler shift to determine the location of an
2 EPIRB.¹⁶ *El Faro*'s EPIRB model did not have a built-in GPS, so the alert was received and forwarded as
3 a "406 beacon unlocated first alert" message. The message was automatically processed at 0739 (1139
4 UTC) and sent as an email to D7CC. No further *El Faro* communications were received by the Coast
5 Guard or TOTE. Figure 4 shows the location of the EPIRB on *El Faro*'s sister ship *El Yunque*.



6
7 **Figure 4.** *El Yunque*'s JOTRON 406 MHz satellite EPIRB in its stowed position on painted red
8 background, aft of bridge on starboard side and forward of blue stack.

9 At 1035, D7CC requested that an Air Force hurricane hunter C-130,¹⁷ which was on a Hurricane
10 Joaquin weather reconnaissance mission, fly over *El Faro*'s last known position, make radio callouts on
11 VHF channel 16, and conduct a radar search. The aircraft did so, with negative results. The hurricane
12 hunter was unable to descend below 10,000 feet because of the storm, and radar detection was ineffective

¹⁶ Bowditch, pp. 403-405.

¹⁷ The WC-130J Hercules is a medium-range aircraft flown by the Air Force Reserve Command's 53rd Weather Reconnaissance Squadron, located at Keesler Air Force Base, Mississippi, for weather reconnaissance missions. The aircraft penetrates tropical disturbances to obtain data on movement, size, and intensity. (Retrieved June 22, 2016: <http://www.af.mil/AboutUs/FactSheets/Display/tabid/224/Article/104561/wc-130-hercules.aspx>).

1 due to excessive feedback from heavy precipitation. At 1106, D7CC requested the inter-island freighter
2 *Emerald Express*, the nearest vessel to *El Faro*, to proceed to *El Faro*'s last known position and assist.
3 The captain of the *Emerald Express* declined, stating that he was in the lee of the Crooked and Acklins
4 Islands attempting to ride out the storm and could not respond—to do so, he said, would expose his vessel,
5 a modified landing craft, to higher seas, and he believed the risk was too great (Figure 5 illustrates
6 hurricane conditions at sea). The *Emerald Express* made callouts to *El Faro* on VHF channel 16, heard
7 by the hurricane hunter, with negative results.¹⁸ The crew of the *Emerald Express* did not inform D7CC
8 when they stopped making radio callouts to *El Faro*.



9

10 **Figure 5.** Photo of unidentified ship encountering Force 12 winds of 64 to 71 knots (hurricane), from
11 Bowditch, *American Practical Navigator*, chapter 37, "Weather Observations," page 543, captioned:
12 "Wave height more than 16 m[eters] (52 ft.); Air filled with foam, sea completely white with driving spray,
13 visibility greatly reduced" <retrieved June 22, 2016, from <http://msi.nga.mil/NGAPortal/MSI.portal>>.
14

¹⁸ SAR (OU) controller 0600-1800 day watch, October 1-2, 2015, D7CC interview transcript and errata, October 13, 2015.

1 SAR Day 2: Friday October 2, 2015

2 CG1503, a C-130 aircraft from Coast Guard Air Station Clearwater, Florida, took off to be on
3 station at first light¹⁹ to conduct parallel search patterns to locate *El Faro*.²⁰ (Figure 6 shows the various
4 assets used to search for *El Faro* and survivors.) The aircraft could not get within 100 nm of the hurricane
5 because of severe winds at 3,000 feet altitude. The aircraft crew reported visibility of 2 nm, heavy rain
6 and spray, and heavy seas, with whitecaps and foam. The aircraft stayed on scene, but when it returned to
7 base, a fuel leak was discovered. The leak was determined to have been caused by the severe weather, so
8 the next sortie was canceled. At 0905, the SMC canceled all additional sorties that day because of rough
9 weather. The SMC explained that an H-60 helicopter flying at 140 knots into 100-knot headwinds would
10 be flying at a speed over the ground of only 40 knots.

11 D7CC worked to position three forward-deployed Coast Guard H-60 helicopters that were
12 participating in Operation Bahamas Turks and Caicos (OPBAT).²¹ Two of the OPBAT helicopters from
13 Air Station Clearwater were forward-deployed on Great Inagua Island, Bahamas, and the third was
14 forward-deployed at the Atlantic Undersea Test and Evaluation Center, on the east side of Andros Island,
15 to support search efforts once the storm moved to the northwest.

¹⁹ First light means roughly dawn, twilight to sunrise. When the Coast Guard specifies first light, aircraft are expected to be on scene at dawn to maximize their ability to search and see something. Source: SAR specialist D17CC Juneau, Alaska, email of August 18, 2016.

²⁰ Compiled from Coast Guard MISLE case 996189, initial notification and 23 updates, and Coast Guard “*El Faro* Next of Kin” PowerPoint presentation, October 7, 2015.

²¹ OPBAT is a combined operation of the US Drug Enforcement Administration, the Coast Guard, and the government of the Bahamas to combat drug smuggling to and from the Bahamas. The OPBAT operations center, located in the American Embassy in Nassau, is responsible for initiating and prosecuting law enforcement cases in the area of responsibility. In addition, OPBAT assets regularly assist with prosecuting human smuggling and SAR cases throughout the area of responsibility. <<https://www.uscg.mil/d7/opbat/>> (downloaded August 15, 2016.) The Tri-part, Grey Agreement, and Comprehensive Maritime Agreements are the main legal bodies of agreements, according to an email from the SAR specialist, Coast Guard District 7, Miami, August 19, 2016.



Figure 6. Coast Guard, Air Force, and Navy SAR assets used to search for *El Faro* and survivors. (Coast Guard graphic)

Two Coast Guard C-130s from Air Station Elizabeth City, New Jersey, taking hurricane avoidance, were temporarily stationed at Coast Guard Air Station Clearwater for the *El Faro* SAR operations. D7CC also tasked the Coast Guard medium endurance cutter *Northland*, on patrol south of Cuba, to assist. The *Northland* was ordered to proceed to the US Naval Base at Guantanamo Bay, Cuba, for a brief stop for fuel and provisions and then to *El Faro*'s last known position, as weather permitted.

Flying above the hurricane on a storm-surveillance mission, an Air Force hurricane hunter C-130 attempted to call *El Faro* on VHF channel 16 and performed a radar search, with negative results. The

only air sorties on the first 2 days of the search were the high-altitude weather surveillance missions by the hurricane hunters and the single Coast Guard C-130 sortie that was unable to get within 100 nm of the storm. D7CC did not include those air sorties as productive SAR sorties in its summary reports.

Other SAR Operations

The *Menouch*, a 212-foot Bolivian-registered ship, began taking on water about 51 nm north of Haiti and was listing 30° when the crew abandoned ship. Twelve crewmembers were rescued by the *Northland's* embarked helicopter at 2212 on October 1 at position 20° 22.0'N, 073° 32.0'W. The Coast Guard also medically evacuated by helicopter a stroke patient from the cruise ship *Carnival Pride*, sailing off the coast of North Carolina, at 0115 on October 2.

SAR Day 3: Saturday October 3, 2015

At 0504 on October 3, a Coast Guard C-130 (CG1503) took off from Air Station Clearwater and was on station at 0654 (0703 sunrise at Nassau, Bahamas) to begin searching and completed a 4-hour aerial parallel search pattern assigned by D7CC, with negative results.²² The aircraft made numerous unsuccessful attempts to break through the wind bands to search the computed drift area of the last known position of *El Faro*. Aircrew reported challenging search conditions on October 3, with visibility as low as 1 nm. Hurricane-force winds caused significant sea spray, white caps, and swells of 20 to 40 feet (see figures 7 and 8). The aircraft reported numerous smaller targets on radar, but nothing as large as *El Faro*.

²² Compiled from Coast Guard MISLE case 996189 initial notification and 23 updates and Coast Guard “*El Faro* Next of Kin” PowerPoint presentation, October 7, 2015.

1 A Coast Guard HC-130 aircraft located a debris field 120 nm northeast of Crooked Island. A Coast
2 Guard MH-60 helicopter relocated the debris field and located three liferings, one of which was stenciled
3 *El Faro*. The helicopter located a second debris field 90 nm northeast of Crooked Island of small
4 unidentified objects believed to be packing material.

5 Seven Coast Guard, Air Force, and Navy aircraft each completed a daylight SAR sortie of 3 to 6
6 hours, for a daily total of 28 hours and an area of 30,581 square miles searched (see figure 9). Three
7 cutters, the *Northland*, the *Resolute*, and the *Charles Sexton*, were en route to the search area as weather
8 and seas permitted.



9
10 **Figure 7.** CG1503, a Coast Guard C-130 aircraft based at Air Station Clearwater, took this photo at an
11 altitude of 500 feet showing challenging search conditions—20 to 40 foot swells—on October 3. (Coast
12 Guard photo)



Figure 8. CG1503, a Coast Guard C-130 aircraft based at Air Station Clearwater took this photo at an altitude of 500 feet showing challenging search conditions on October 3, when hurricane-force winds caused significant sea spray and whitecaps. (Coast Guard photo)

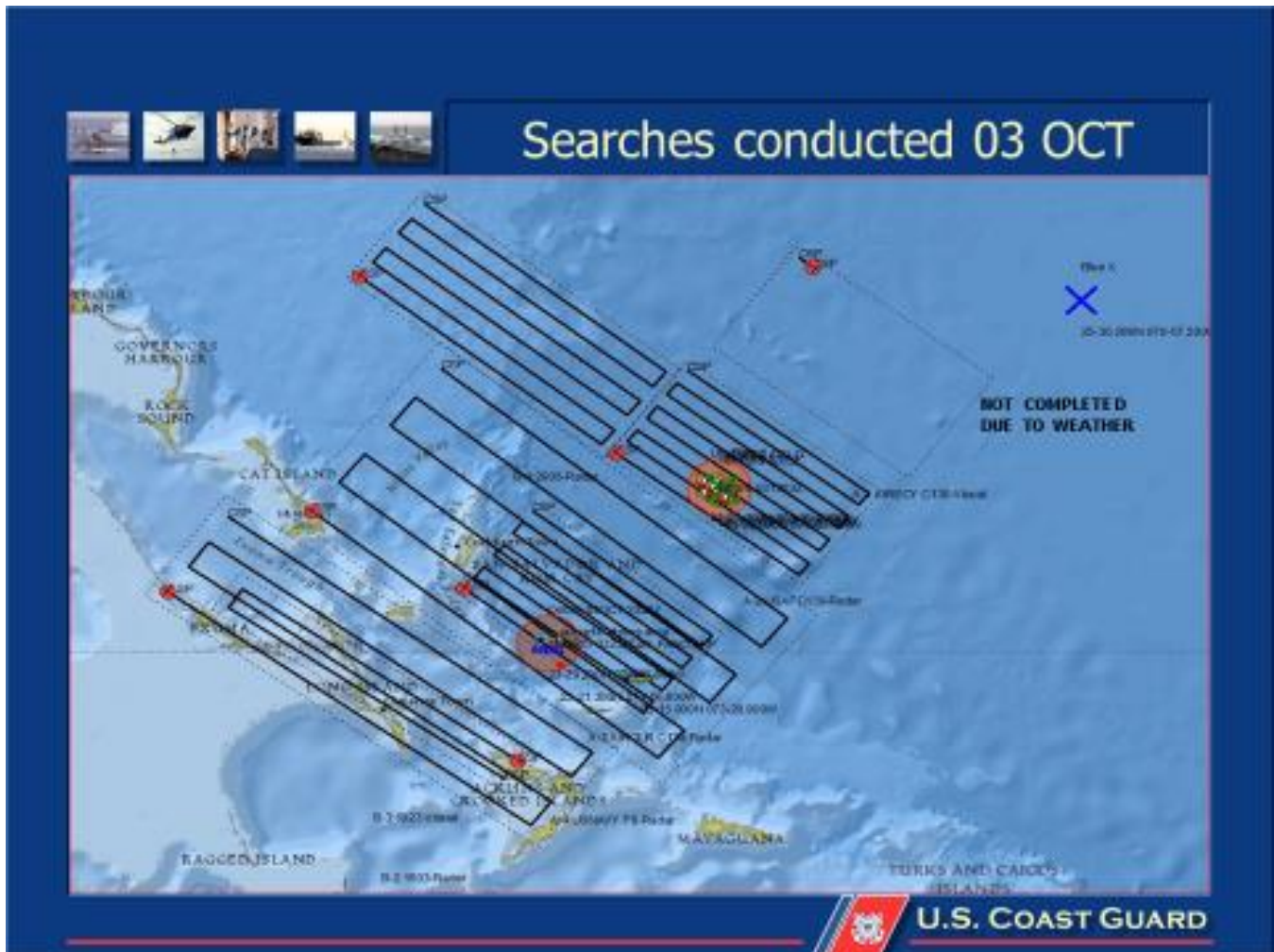


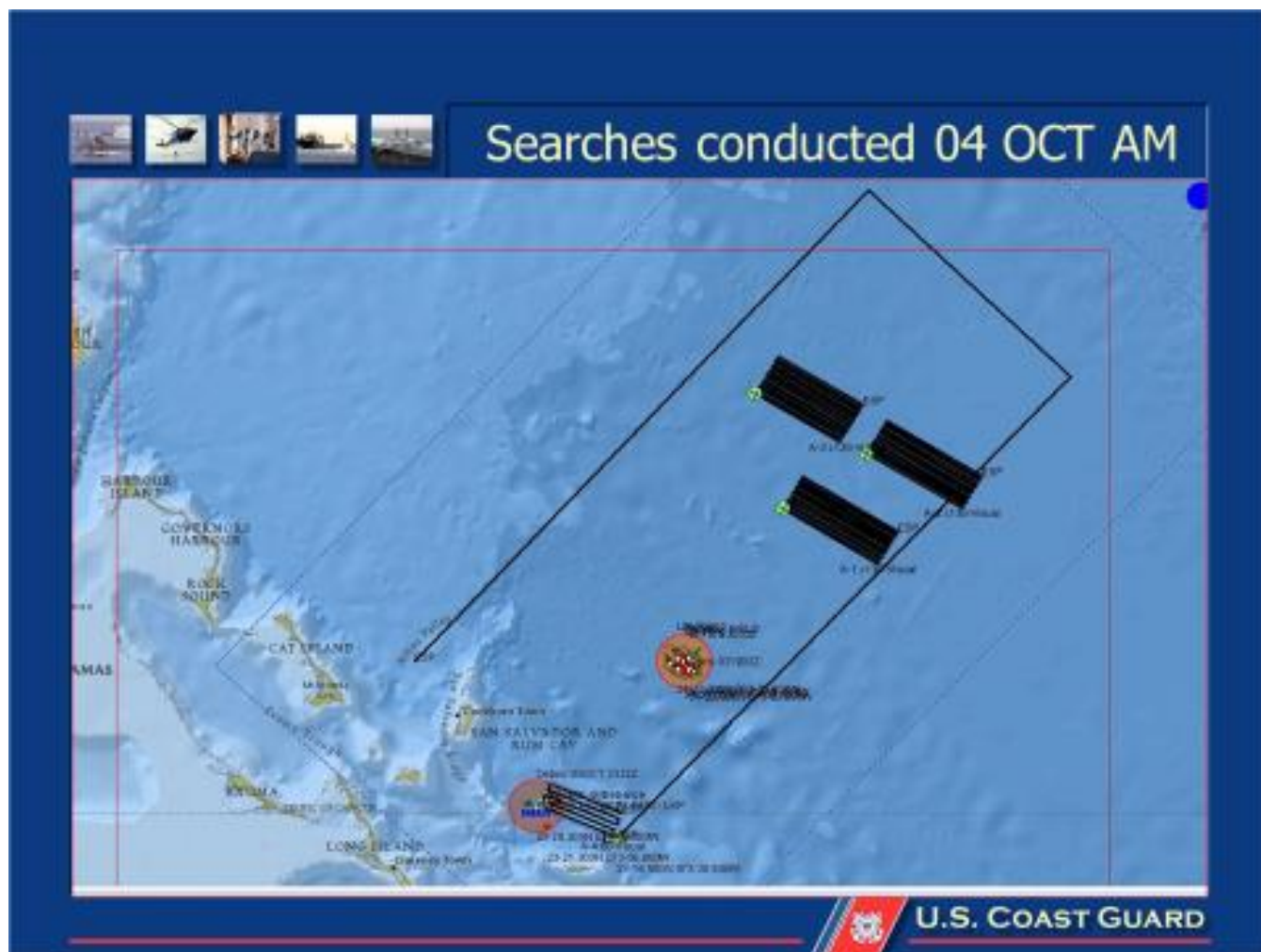
Figure 9. Parallel search patterns conducted on October 3 by Coast Guard, Air Force, and Navy air assets. (Coast Guard graphic)

SAR Day 4: Sunday October 4, 2015

At 0100 on October 4, the cutter *Northland* arrived on scene and assumed duty as on-scene commander of SAR operations. Three HC-130 aircraft (two Coast Guard and one Air Force), a Navy P-8 aircraft, and a Coast Guard MH-60 helicopter completed first-light and morning searches (see figure 10).²³ The Coast Guard HC-130 and MH-60 located the two separate debris fields spotted earlier. Weather

²³ Compiled from Coast Guard MISLE case 996189 initial notification and 23 updates, and Coast Guard “*El Faro* Next of Kin” PowerPoint presentation, October 7, 2015.

1 conditions in the search area on October 4 were reported as visibility 10 nm, winds 15 to 20 knots, and
 2 seas 2 to 3 feet.



3
 4 **Figure 10.** Morning parallel search patterns conducted on October 4 by Coast Guard, Air Force, and
 5 Navy surface and air assets. (Coast Guard graphic)

6
 7 Three tugs chartered by TOTE—*Sentinel*, *Sentry*, and *Hawk*—and the cutter *Resolute*, carrying an
 8 MH-65 helicopter, arrived on scene about 1130 and began assisting with SAR and salvage duties. The
 9 TOTE vessel *El Yunque* searched as it transited the area on its voyage from Jacksonville to San Juan. At
 10 1500, an MH-60 helicopter located *El Faro*'s swamped starboard lifeboat at 23°24.2'N, 073°54.5'W, about
 11 7 nm west-southwest of *El Faro*'s INMARSAT-C position. The helicopter's rescue swimmer was

1 deployed to investigate and found the lifeboat heavily damaged, with no one aboard. The tug *Hawk* was
2 directed to investigate and recover the lifeboat.

3 The Navy P-8 reported two liferafts in separate locations. At 1806, the cutter *Northland* found one
4 of the liferafts at 23°29.2'N, 073°35.3'W. The ship's rescue swimmer searched the partially inflated liferaft
5 for any sign of survivors.²⁴ Finding no one on board, the *Northland* sank the liferaft to prevent its being
6 rediscovered and proceeded to the position of the second liferaft. The *Northland* could not find the second
7 liferaft, whose position the Navy P-8 had reported at 1145 to be 23°24.7'N, 073°54.9'W.

8 At 1657, the Navy P-8 reported an orange immersion suit about 40 nm west-northwest of *El Faro*'s
9 last known position. At 1823, a Coast Guard MH-60 helicopter located an immersion suit in that area. The
10 helicopter's rescue swimmer found that the immersion suit contained human remains. He described the
11 remains as being in an advanced stage of decomposition. The head was three times larger than normal,
12 and the gender and race could not be determined.²⁵ About the same time, the Navy P-8 reported another
13 immersion suit 30 nm away, with a possible person in it waving its arms. Based on the report of a potential
14 surviving crewmember, the Coast Guard helicopter crew decided not to recover the remains at that time
15 and to move toward the position reported by the Navy aircraft. The helicopter recovered its rescue
16 swimmer and dropped a self-locating datum marker buoy (SLDMB)²⁶ by the remains, but it was
17 discovered later that the SLDMB failed to transmit its position.²⁷ The helicopter could not find the second

²⁴ The liferaft size (25-person or 6-person) and marking were not recorded in the Coast Guard's MISLE database.

²⁵ SAR rescue swimmer interview transcript and errata, NTSB-Coast Guard, February 11, 2016.

²⁶ SLDMBs are oceanographic surface drifting buoys that are ship or air deployable. The Coast Guard deploys approximately 500-600 SLDMBs annually for its SAR operations. SLDMB positional data are used to estimate the movement of a search object within a search area. Downloaded from NOAA Satellite Information System on August 25, 2016: http://www.noaasis.noaa.gov/ARGOS/docs/SUA_January_2013.html.

²⁷ According to the Coast Guard, the SLDMB begins transmitting real-time GPS position and water temperature to a satellite, which is updated every 30 minutes for 10 days. This version 2 SLDMB had a 62 percent success rate, a 16 percent partial success rate, and a 22 percent failure rate. After the accident, the Coast Guard transitioned to a new Iridium SLDMB.

reported immersion suit and at sunset, returned to attempt to recover the remains. The crew was unable to relocate the remains.²⁸ The helicopter aborted the search at darkness, and the *Northland* went to the scene to search throughout the night. The immersion suit with human remains was never recovered. Figure 11 shows the location of the *El Faro* debris fields and objects discovered during SAR operations.

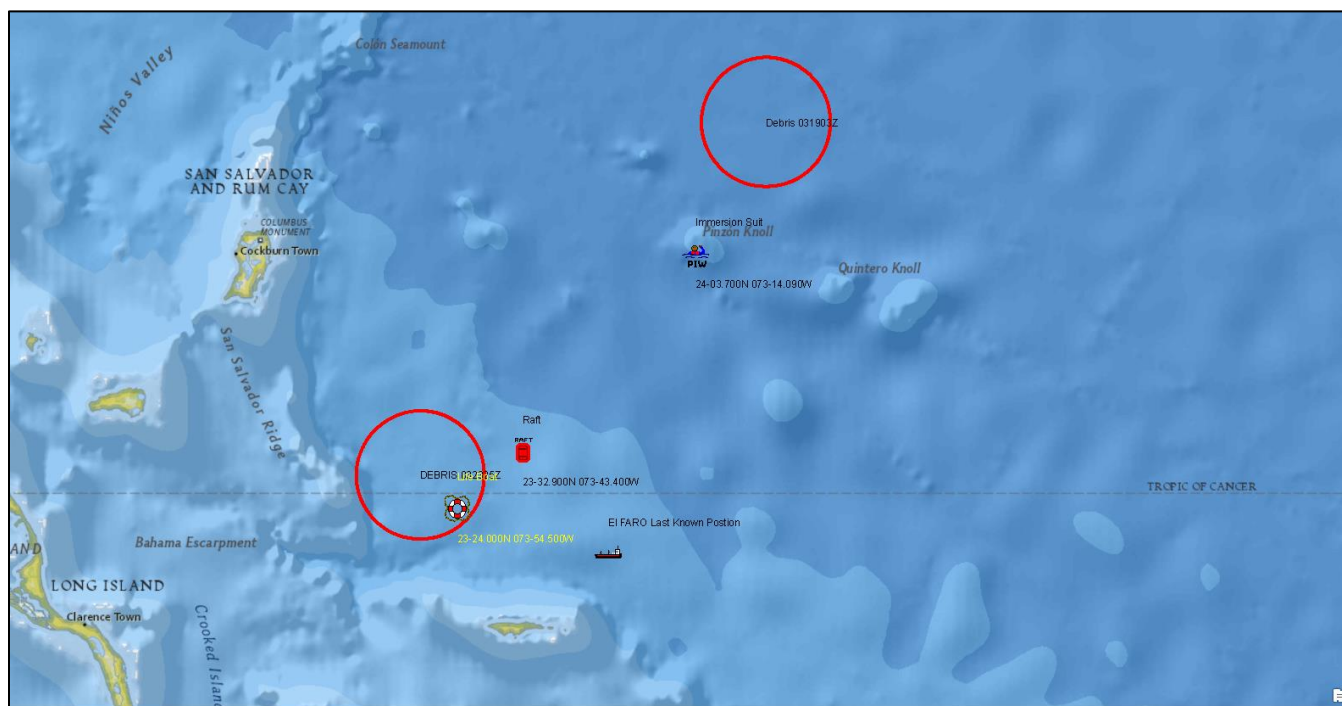


Figure 11. Last known position of *El Faro* (ship symbol) and two debris fields²⁹ (red circles). First debris field was located bearing 293° true at 31 nm from the last known position; second debris field was located bearing 020° true at 72 nm from *El Faro*'s last known position. Each debris field had a radius of about 10 nm; the distance between the debris fields was 76 nm. Major survival gear found were lifeboat (lifering symbol), liferaft (red raft symbol), and immersion suit with human remains (PIW symbol). (Coast Guard graphic)

Coast Guard and Navy fixed-wing aircraft and Coast Guard and salvage tugs searched throughout the evening. Coast Guard, Air Force, and Navy aircraft and the cutter *Northland* completed 12 SAR sorties

²⁸ SAR helicopter pilot-in-command interview transcript and errata, NTSB-Coast Guard, February 11, 2016.

²⁹ SAR specialist, D7CC, email, "El Faro Two Different Debris Field Questions," August 26, 2016.

1 Guard C-130. Searchers reported that visibility was unlimited, winds were 14 knots, and seas 2 to 3 feet.
2 In the early morning, an Air Force high-altitude JSTARS reconnaissance aircraft assisted the search effort
3 while transiting the search area. The JSTARS conducted high-altitude sweeps of 19,305 square miles at a
4 time, confirmed the debris fields, and confirmed that there was no large vessel in the search area. This
5 information helped to confirm that *El Faro* had sunk and changed the accident into a major marine
6 casualty.³¹

7 At 1000, the Coast Guard announced at a morning press conference that the search would continue
8 for survivors, but based on the debris found, it was likely that *El Faro* had sunk. A Navy P-8 aircraft
9 continued to support the search efforts using a highly sensitive radar. The P-8 was initially used to search
10 for the vessel at a very high altitude, which significantly increased the amount of area searched. As weather
11 conditions improved, the P-8 began to fly at lower altitudes (2,500 feet) to search for smaller objects.
12 Searchers began recovering *El Faro* survival equipment during the day.³² Three lifebuoys, stenciled *El*
13 *Faro* or *El Morro*, were recovered and secured on board the cutter *Resolute* and the tug *Sentry*.

14 Other recovered debris that was possibly from *El Faro* included a blue plastic parking curb, a
15 refrigerated container door, an orange recreational personal flotation device (PFD), and dozens of toy dolls
16 covering an area of about 20 nm. The three cutters continued to search throughout the night. The three
17 tugs remained on scene to support the search. D7CC reported that Coast Guard, Navy, and Air Force
18 aircraft and three cutters completed 13 SAR sorties of 1 to 24 hours in duration, for a daily total of 77
19 hours and an area of 44,910 square miles searched (see figure 13).

³¹ SMC, Coast Guard D7 interview transcript and errata, October 14, 2015.

³² These were the first *El Faro* survival debris to be recovered. The partially inflated liferaft and the human remains were not recovered.

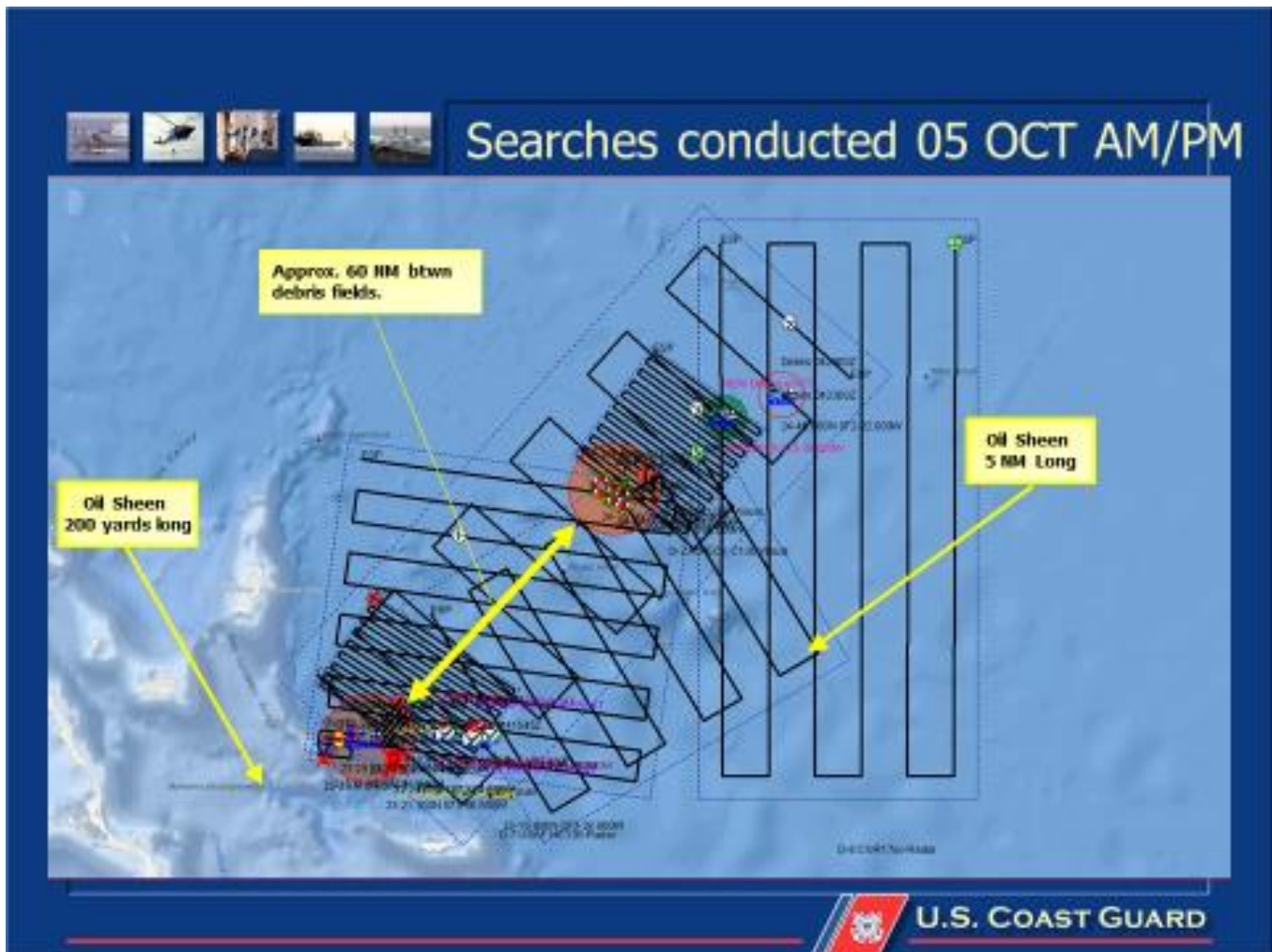


Figure 13. Parallel search patterns conducted on October 5 by Coast Guard, Navy, and Air Force air and surface assets. (Coast Guard photo)

SAR Day 6: Tuesday October 6, 2015

A fixed-wing Navy P-8 and a Coast Guard C-130 completed morning searches, with negative results.³³ An MH-60 helicopter searched for washed-up debris along the Bahamas island chain near Long Island, Great Exuma, and Cat Island. The three cutters continued to follow search patterns, and the three

³³ Information in this section compiled from Coast Guard MISLE Case Number 996189 initial notification and 23 updates and Coast Guard "El Faro Next of Kin" PowerPoint presentation, October 7, 2015.

tugs remained on scene to support. Three C-130 aircraft (one Coast Guard and two Air Force) searched in the afternoon. Searchers reported visibility was 10 nm, winds from 190° at 5 knots, and seas 1 to 2 feet. At 1808, the cutter *Charles Sexton* recovered an empty survival suit, stenciled *El Faro*, at position 24°03.8'N, 073°14.1'W.

The three cutters continued to search throughout the night, and the three tugs remained on scene supporting the search. Coast Guard, Navy, and Air Force aircraft and cutters completed 11 SAR sorties lasting 2 to 24 hours, for a daily total of 40 hours and an area of 11,792 square miles searched (figure 14).

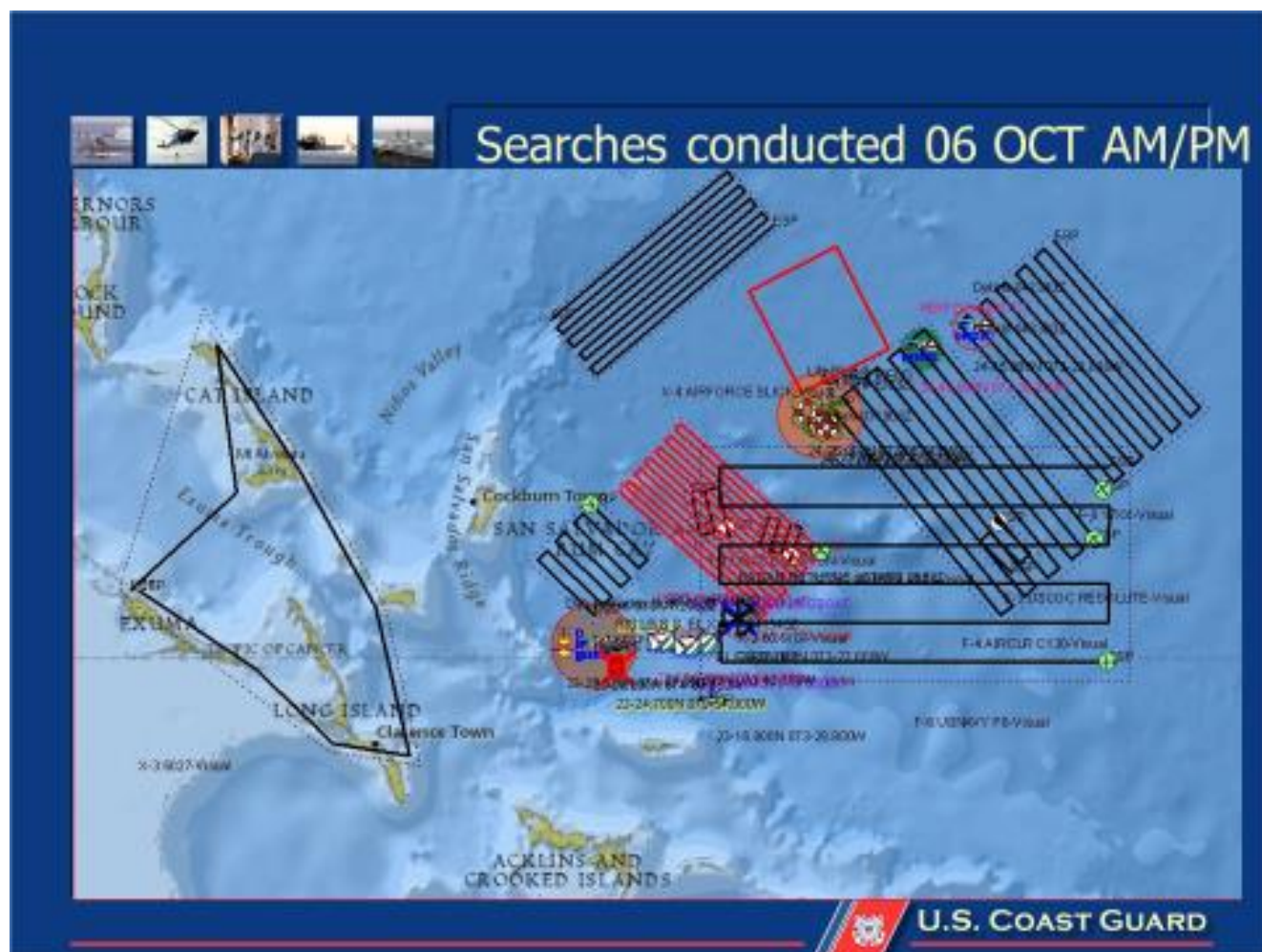


Figure 14. Parallel search patterns and search of island beaches conducted on October 6 by Coast Guard, Navy, and Air Force air and surface assets. (Coast Guard graphic)

SAR Day 7: Wednesday October 7, 2015

A Navy P-8 and three C-130 (two Coast Guard and one Air Force) aircraft searched from 0800 to sunset, with no significant sightings.³⁴ The three Coast Guard cutters (*Northland*, *Resolute*, and *Charles Sexton*) searched throughout the day. At 1433, the *Charles Sexton* located and recovered a second empty *El Faro* survival suit at position 23°58.8'N, 073°19.4'W. The three tugs chartered by TOTE (*Hawk*, *Sentinel*, and *Sentry*) were on scene supporting search efforts. Searchers reported that visibility was 10 nm, winds were from 227° at 3 knots, and seas were 1 foot.

At 1900 (sunset), the Coast Guard reported that from October 3 to October 7, a total of 50 air and surface sorties were conducted, with over 274 hours of active searching for *El Faro* and survivors. A total of 15 different Coast Guard, Air Force, and Navy air and surface assets searched 195,601 square miles without locating any survivors (figure 15).

Because the probability of survival decision aid (PSDA)³⁵ survivability time of 120 hours had been exceeded without finding survivors (154 hours actual time in the water), the Coast Guard suspended active search for the 33 persons on *El Faro* pending further developments. The Commander of Coast Guard District 7 informed the crew's family members before officially ending the search at sundown. All Coast Guard, Air Force, and Navy SAR assets were released at that time.

³⁴ Compiled from Coast Guard MISLE Case Number 996189 initial notification and 23 updates and Coast Guard "El Faro Next of Kin" PowerPoint presentation, October 7, 2015.

³⁵ Since June 22, 2010, the Coast Guard has used the PSDA for all cases involving persons in the water and where persons are at risk of hypothermia or dehydration when not immersed. The PSDA model is a physiological-based model of both heat and water loss for survivors immersed in water or out in open air.

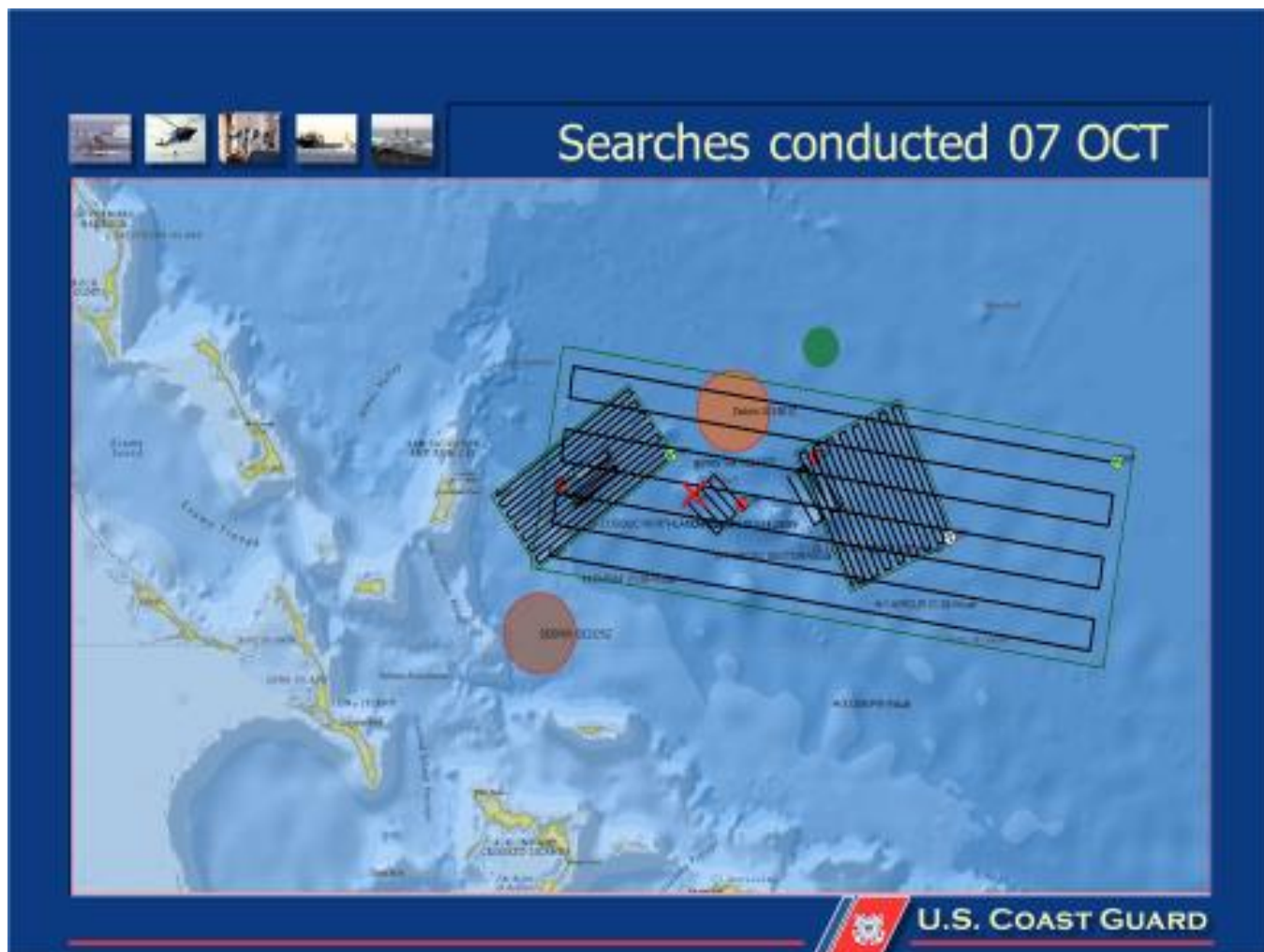


Figure 15. Search patterns conducted on October 7 by Coast Guard, Navy, and Air Force air and surface assets. (Coast Guard graphic)

5.4. Coast Guard Search and Rescue Optimal Planning System (SAROPS)

SAROPS³⁶ is the software used by the Coast Guard for maritime search planning. The program is a Monte Carlo-based system³⁷ in a wizard-based graphical user interface. SAROPS can handle multiple scenarios and types of search objects, model predistress motion and hazards, and account for the effects

³⁶ "US Coast Guard SAROPS Fact Sheet" (downloaded from SAR Program Information on July 6, 2016 <https://www.uscg.mil/hq/cg5/cg534/SAR_Program_Info.asp>).

³⁷ Monte Carlo simulation uses thousands of simulated particles generated by user inputs and observes where most of the particles move.

1 of previous searches. SAROPS 2.0 was rolled out to Coast Guard District 7 on July 15, 2015, with web-
2 based training from SAR school instructors. Glitches and frustrations were noted, and District 7 compiled
3 a list from controllers in the six sectors.

4 When the SAR OU watchstanders at the RCC tried to reopen the SAROPS 2.0 program case file
5 during the *El Faro* SAR operation, it did not provide a search action plan. The program locked up and
6 could not run simulations, so the watchstanders contacted technicians at the Coast Guard Command,
7 Control and Communication Engineering Center in Portsmouth, Virginia, to troubleshoot.

8 SAROPS 2.0 was limited to winds of up to 40 knots and a vessel of up to 300 feet. Because there
9 was no automated SAR backup, the senior member of D7CC used manual set and drift computations,
10 minimum/maximum calculated assessments that worked when two drift fields were later found 60 nm
11 apart. It was later discovered that the *El Faro* SAROPS case disappeared because the controllers had built
12 the SAR case(s) in different computer servers.³⁸ According to the District 7 SAR specialist, SAROPS 2.0
13 was frustrating, and the watchstanders found there was no redundancy or backup SAR program in place
14 in case the SAR program went down.³⁹ As weather improved, SAROPS was used successfully to provide
15 search areas to air and surface SAR assets.

16 **5.5. Survival Gear**

17 *El Faro* was required to carry certain survival gear by its Coast Guard certificate of inspection
18 (COI), last issued on February 22, 2011. The type and quantity of survival equipment carried on the vessel,
19 as listed by ABS in its “Record of Approved Cargo Ship Safety Equipment” dated February 23, 2006

³⁸ SAROPS Program Manager, U.S. Coast Guard HQ, Washington, DC; and ManTech Senior Field Engineer, (C3Cen) U.S. Coast Guard Command, Control & Communication Engineering Center Portsmouth, VA transcript of interview, June 15, 2016

³⁹ SAR Specialist, Coast Guard District 7, Miami, FL transcript of interview, June 14, 2016.

(with equipment updates on February 23, 2007, February 2, 2009, and April 2, 2010), are shown in Table 3. The table also indicates whether the equipment was detected or recovered after the accident.

Table 3. Life-saving appliances required by *El Faro's* COI.

Appliance	No. Required by COI	Persons to Accommodate	Onboard per ABS Records	Found or Detected after Accident	Recovered
Lifeboat (starboard)	1	43	1	1	1
Lifeboat (port)	1	43	1	1	0
Inflatable rafts (liferafts)	3	46	5 ^a	2	0
Life preservers (lifejackets)	45	1 each	46	1	1
Ring buoys (lifebuoys):	14	1 each	30	8	8 ^b
<i>With lights</i>	(8)	(c)	--	--	--
<i>With line attached</i>	(2)	(c)	--	--	--
<i>Other</i>	(4)	(c)	--	--	--
Immersion suits	45	1 each	50	3	2
Portable lifeboat radios	2	n/a	3	0	0
EPIRB	1	n/a	1	0	0

NOTE: n/a = not applicable.

^aTwo extra liferafts were on board. According to TOTE, when two liferafts (25 persons each) were added to *El Yunque* as a precaution when corrosion was found on the lifeboat davits, the same addition was made to *El Faro*.

^bNone of the recovered ring buoys had attachments. Of two smoke floats, one was recovered and one was detected on ocean floor.

^cIncluded in total.

Table 4 summarizes the survival gear carried on *El Faro*. Both lifeboats were manufactured by Marine Safety Equipment Corporation (MASECO), founded in 1945 in Point Pleasant, New Jersey,⁴⁰ and merged into Schat-Watercraft Inc., in 1991.⁴¹ In 2013, Schat Harding and Noreq was acquired by Herkules Capital and merged as Harding Safety AS.⁴² Harding Safety USA, Inc., is the service provider for

⁴⁰ J. Woolley, *Images of America Point Pleasant Volume II* (Arcadia Publishing, 1997, p. 126). Downloaded August 23, 2016, from <<https://books.google.com/books>>.

⁴¹ Harding attorney email to NTSB, June 22, 2016.

⁴² Harding Company History, downloaded July 7, 2016 <<https://www.harding.no/company/history>>.

1 MASECO lifeboats. On June 30, 2016, Herkles Harding Holding AS was acquired by PALFINGER
2 Group.⁴³

3 In Table 4, “Former—May Use” indicates that the manufacturer no longer makes the equipment,
4 that the Coast Guard certificate of approval (COA) was in effect indefinitely, that the COA was no longer
5 kept on file by the Coast Guard, and that the COA had been transferred to the National Archives in
6 Washington, DC, for storage. Coast Guard approval numbers were provided by Harding Safety USA, then
7 searched on a Coast Guard database. The Coast Guard could not do a direct search by ship for COAs
8 applicable to *El Faro*’s “Former—May Use” lifesaving equipment. A record search by Harding Safety
9 USA indicates that the survival systems (lifeboat, davit to lower the lifeboat to the water, winch to recover
10 the lifeboat, and hook to release the lifeboat) were original equipment.⁴⁴

11 **Table 4.** Details of survival equipment carried by *El Faro*.

Equipment	Manufacturer	Manufacture Date	Approval	Characteristics
Lifeboat 1 (starboard)	MASECO ^a	9/5/1974 (boat 2413)	Coast Guard no.: 160.35/461/0 Issued: 4/11/1980 Exp.: 9/6/1986 Status: “Former—may use lifeboat for merchant vessels”	Dimensions: 26.5 ft x 9 ft x 3.83 ft Capacity: 43 persons Construction: open Propulsion: mechanical (hand-propelled Fleming gear) Material: fiberglass-reinforced plastic (FRP) with internal buoyancy foam Launch: gravity davit Recovery: winch
Lifeboat 2 (port)	MASECO	unknown (boat 2412)	Coast Guard no.: 160.035/460/0 Issued: 5/9/1975 Exp: 6/2/1980 Status: “Former—may use lifeboat for merchant vessels”	Vessel’s rescue boat Dimensions: 26.5 ft x 9 ft x 3.83 ft Capacity: 48 persons Wt. (full load): 12,782.4 lb Construction: open Propulsion: motor (diesel engine) Material: FRP with foam Launch: gravity davit Recovery: winch

⁴³ “PALFINGER Closes Harding Acquisition,” downloaded November 7, 2016 <<https://www.palfinger.com/en/marine/> and <https://www.harding.no/news/palfinger-closes-harding-acquisition/>>.

⁴⁴ Harding Safety USA attorney email, “Coast Guard MBI,” sent to Coast Guard attorney, Monday, June 6, 2016.

Equipment	Manufacturer	Manufacture Date	Approval	Characteristics
Davits (same on both lifeboats)	MASECO	unknown	Coast Guard no.: 160.032/173/0 Issued: 3/16/1982 Exp.: 3/16/1987 Status: "Former—may use"	Type: gravity Serial no.: 26-15 Maximum working load: 15,000 lb per set (7,500 lb per arm) using 2-part falls
Winch (same on both lifeboats)	MASECO	unknown	Coast Guard no.: 160/015/93/2 Issued: 11/12/1988 Exp.: 11/12/1993 Status: "Former—may use lifeboat winch for merchant vessels"	Type: 35G-MK II Model: 256 Serial no.: 1070-1 Load: 3,750 lb per fall
Release hook (same on both lifeboats)	MASECO	unknown	(b)	Type: Rottmer SWL 7000
Liferaft 1	Viking Life-Saving Equipment	11/2005	No. 160.151/117/0 Issued: 6/24/2015 Exp: 6/24/2020 Status: Approved	Type: inflatable Serial no.: Viking 25DK+10245946 Capacity: 25 persons Location: boat deck, starboard side Inspected: 9/4/2015 Next Insp: 9/2016
Liferaft 2	Viking Life-Saving Equipment	11/2005	same	Type: inflatable Serial no.: Viking 25DK+10245947 Capacity: 25 persons Location: boat deck, port side Inspected: 9/4/2015 Next Insp: 9/2016
Liferaft 3	Viking Life-Saving Equipment	11/2010	Coast Guard no. 160.151/108/0 Issued: 6/24/2015 Exp: 6/24/2020 Status: Approved	Type: inflatable Serial no.: Viking 06DK+11355928 Capacity: 6 persons Location: port side, forward on main deck Required on vessels over 100 m long Inspected: 5/18/2015 Next Insp: 5/2016
Liferaft 4	SURVITEC Group, Ltd.	7/2015	Coast Guard no. 160.151/130/3 Updated: 6/24/2014 Issued: 8/22/2016 Exp: 6/24/2019 Status: Approved	Type: inflatable Model: Elliot SOLAS style Mk IV TO Serial no.: 5086300200735, lot 2451 Capacity: 25 persons Manufactured: 7/2015 Next Insp: 7/7/2017
Liferaft 5	SURVITEC Group, Ltd.	7/2015	same	Type: inflatable Model: Elliot SOLAS style Mk IV TO Serial no.: 5086300200613, lot 2463 Capacity: 25 persons Manufactured: 7/2015 Next Insp: 7/27/2017

Equipment	Manufacturer	Manufacture Date	Approval	Characteristics
Lifejackets (46)	Safeguard Corporation	unknown	Coast Guard no. 160.002/70/0 Issued: 12/6/2004 Exp: 12/6/2009 Status: "Former—may use"	Type: with whistle and light Model: 3, 190, or 190RT KAPOK most recent Type 1 on CG EQList database Location: crew quarters (41); bridge (2); engine room control station (2); bow (1)
Lifebuoys	Datrex, Inc.	For 2 recovered: 12/2004, 11/2008	Coast Guard no. 160.050/127/0 Update: 1/29/2009 Issued: 1/29/2014 Exp: 1/29/2019 Status: Approved	Size: diameter = 30 in. Type: with self-igniting ACR lights (8); quick-release with light and smoke signals (2); with buoyant line (6); without attachments (13) Location: weather decks, except 2 quick-release on port and starboard bridge wings
Immersion suits	Various: Stearns, Baileys, Fitz-Wright, O'Neil, Mustang (unknown for 4 new suits)	For 1 recovered: 6/1985 (Imperial Manufacturing Co.)	Imperial not listed on CG EQList database under 160.171 for immersion suits	Type: Adult universal Model: 1409; Serial nos. 94797, lot 348; and 95015, lot 351/6 Size: total includes 4 oversize, newly purchased Location: crew quarters
EPIRB	Jotron	unknown	FCC: Type-accepted Coast Guard:: 161.011/91/0 Issued: 3/26/2008 Exp: 3/26/2018 Status: Approved	Model: Jotron Tron 40S MkII Frequency: 406.037 MHz Serial nos.: 09170 (on 1/27/2015 safety survey by Imtech Marine/Radio Holland); ADCDO 28F4A 40C01 (ID FCC registration); 49989 (on ABS certificate) Antenna: omnidirectional, 5 watts GPS: none Operating life: minimum 48 hr Battery exp.: 2/1/2019 Release: manual or hydrostatic Bracket: Type FB-6; Serial 03101 Hydrostatic release expires: 2/1/2016 Date Registered: 2/1/2012 Last Update: 12/3/2013 Decal Expires: 12/3/2015 In service: 2/16/2007, Jacksonville FL
Lifeboat radios	ACR Electronics	unknown	FCC: B668L2ACR-SR-102 Issued: 2/8/200 Exp: none	Serial nos. (battery exp): 952061 (1/1/2019); 14609 (1/1/2019); 95703 (12/12/2018) Model: SR-102R, 2-channel VHF GMDSS survival Radio
Search and rescue transponders (SART)	Jotron	unknown	FCC: VRVTRONSART20 Issued: 5/16/2008 Exp: none	Model: Tron, SART, 9 GHz Serial nos.: 10595, 10601 Both units' batteries exp.: 2/1/2018 Operation life: 96 hr standby, 8 hr continuous Trigger: X-band radar on SAR vessel
Simplified VDR	Danelec Marine	See Electronic Group factual report	See Electronic Group factual report	Model: Sperry Marine VoyageMaster II Serial no.: A06032-000937 In service: 2/2/2009, Mobile AL

Equipment	Manufacturer	Manufacture Date	Approval	Characteristics
Long-range identification and tracking (LRIT)	Thrane &Thrane	unknown	Coast Guard no. 165.207/1/0 Issued: 3/16/2009 Exp: 3/16/2004 Status: Expired FCC cert. required	Model: TT-3000LRIT ID: 4TT088FF662A Freq: Rx and Tx GPS: 1575.42MHz GPS module: 12-ch; 1 sec updates Serial: 436820881 TT-3026M Mini- C transceiver In service: 4/2/2010, Baltimore MD Last ABS survey: 4/15/2010

NOTE: "Former" approval status indicates that "product is no longer approved for production but previously produced items may continue to be used as long as in good and serviceable condition" (Coast Guard Maritime Information Exchange, Approved Equipment List).
FCC = Federal Communications Commission.

^a Now Schat Marine Safety Corporation, Farmingdale NJ 07727.

^b COA not found on Coast Guard database for series 160.033 (Lifeboat Mechanical Disengaging Apparatus) or series 160.133 (Lifeboat Release Mechanism [SOLAS]). Request has been submitted to CG-ENG-4 (Type Approvals, Lifesaving & Fire Safety Division).

Lifeboats

El Faro was equipped with two motor-propelled open lifeboats. The starboard lifeboat (No. 1) was mechanically propelled (manual Fleming gear). The port lifeboat (No. 2) was propelled by a diesel engine. Open lifeboats and mechanically propelled lifeboats are allowed only on ships constructed before July 1, 1986. International lifeboat standards and regulations are discussed in detail in section 5.17. Details of the lifeboats are listed in Table 4, above.

A Harding Safety USA technician was aboard *El Faro* on August 4, 2015⁴⁵ to conduct the annual inspection of the lifeboats and associated launching appliances. The technician noted in his service report that the davits, winches, lifeboats, and hooks were serviced and inspected and found to be in operational condition, with no major faults observed. In particular: the limit switches were inspected, tested, and found to be working properly; the brakes were opened and inspected; brake tests were performed by lowering an empty boat and applying the brake abruptly; testing of the engine and the hook release was performed

⁴⁵ Harding Safety USA, Inc., work instruction and service report, August 4, 2015.

1 in the water on the port side (because the vessel was moored to starboard, the starboard lifeboat needed to
2 be lowered to the water and perform the hook-release test). The technician noted that the winches and
3 davits were showing some scale or corrosion on hardware and foundations, and *El Faro*'s crew was to
4 clean the corrosion and paint by the technician's follow-up visit scheduled for November 4, 2015, when
5 the technician was to be back to repair fiberglass damage on the lifeboats from lashings securing the
6 lifeboats. The technician recommended replacing both freewheel clutches, which were leaking oil, and
7 the starboard winch clutch, which was noted to make a "strange noise."

8 Another Harding Safety USA technician was onboard *El Faro* on September 28 and 29, 2015,⁴⁶
9 to remove and install two new freewheel clutches in the lifeboat winches and to test for proper working
10 order. On September 29, the technician noted in his service report that after installation, both lifeboat
11 brakes and winches were tested and found to be in proper working order. A TOTE port engineer testified
12 at the Coast Guard MBI hearing that the company did not notify ABS or the Coast Guard to give them an
13 opportunity to attend the work on the lifeboat winches.

14 The starboard lifeboat was discovered during the SAR operation at 1500 on October 4 at
15 23°24.2'N, 073°54.5'W. The boat was swamped, floating bow up (figure 16). The lifeboat was too big for
16 the tug *Hawk* to recover, so TOTE chartered the offshore support vessel *Megan Beyel* to salvage the boat
17 and deliver it to the Port of Miami. The lifeboat was brought to Coast Guard Air Station Miami and
18 inspected (figure 17). Damage is noted in Table 5, below. Figure 18 shows the starboard lifeboat in its
19 davit before the accident.

⁴⁶ Harding Safety USA, Inc., work instruction and safety report, September 29, 2015.



3



1

2 **Figure 17.** *El Faro*'s starboard lifeboat as it arrived at Coast Guard Air Station Miami. Note fouled
3 propeller, bent propeller blade, and damage to port and starboard sides of the hull.

4



Figure 18. Photo taken before accident of *El Faro*'s starboard lifeboat stowed in gravity davits. (Photo by *El Faro* deck cadet)

The diesel-operated port lifeboat, MASECO boat number 2412, was not found during the 7 days of *El Faro* recovery operations. During the first VDR search mission, the wreckage of *El Faro* was examined. Investigators noted that the lifeboat was not in its davit (for comparison, figure 19 shows the sister ship *El Yunque*'s port lifeboat in stowed position).

On the second VDR search mission, searchers discovered the port lifeboat on the sea floor, position 23°23.5'N, 073°54.5'W, at a depth of 4,697 meters (15,410 feet); see figure 20. The lifeboat was roughly 300 meters (984 feet) north-northeast of the bridge wreckage and about 1,300 meters (4,265 feet) north-

1 northeast of the midships section of *El Faro*'s hull. The major damage noted was that a portion of one end
2 of the lifeboat had been cut off (it was not found). See figures 20, 21, and 22 for photos related to *El*
3 *Faro*'s lifeboats taken during underwater VDR search. More information about the search for *El Faro*'s
4 VDR will be found in the factual report produced by the investigation's Electronic Data Group.



Figure 19. *El Yunque*'s port lifeboat in stowed position.



Figure 20. Photo mosaic of *El Faro*'s port lifeboat discovered by downlooking camera during underwater search by Woods Hole Oceanographic Institute vessel *Atlantis*, April 2016.

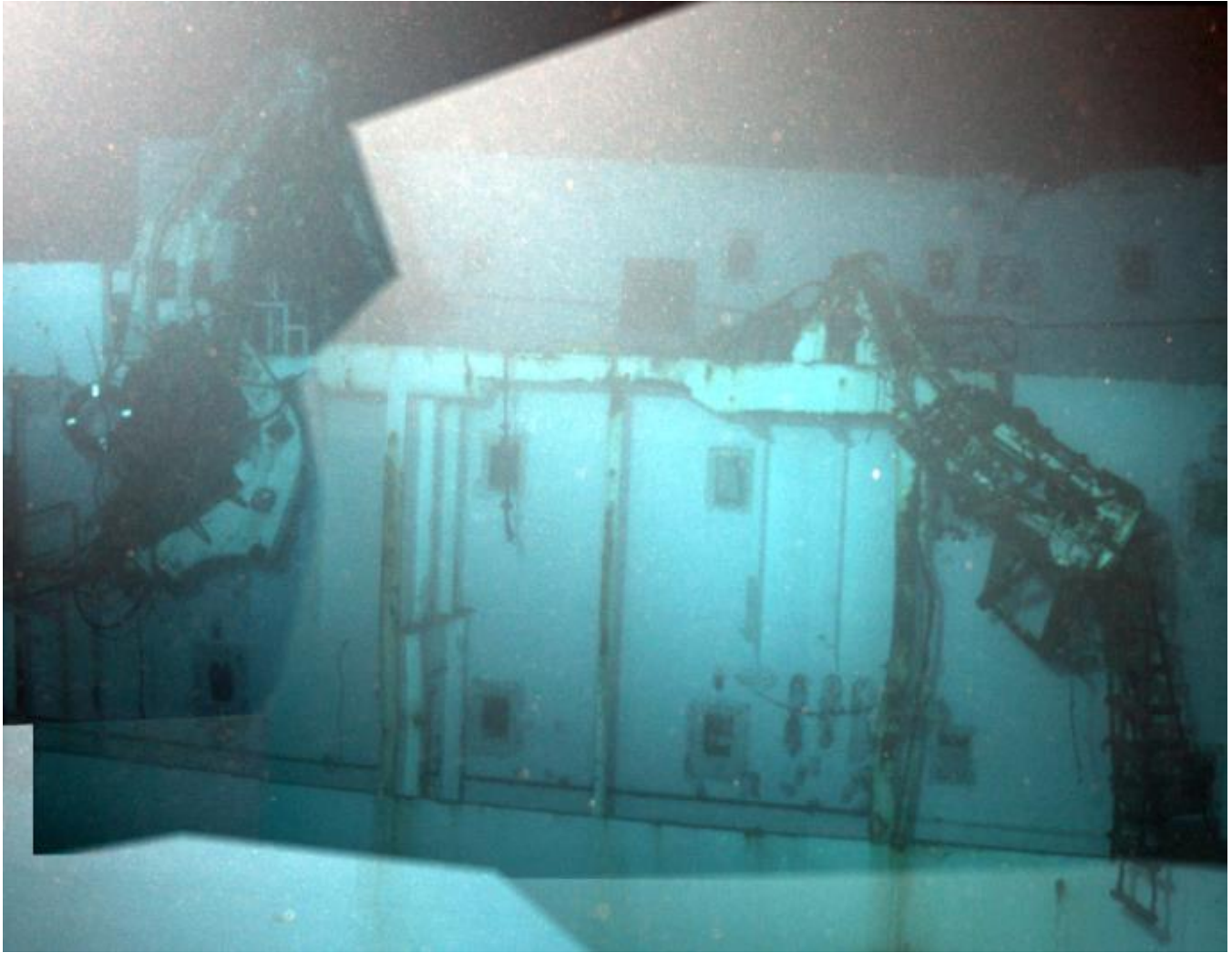
1



2

3 **Figure 21.** Photo mosaic of starboard lifeboat's "intact" gravity davits from camera flyover on second *EI*
4 *Faro* VDR search voyage by vessel *Atlantis*, April 2016.

5



1

2 **Figure 22.** Photo mosaic of port lifeboat's "broken" gravity davits from camera flyover on second *El Faro*
3 VDR search voyage by vessel *Atlantis*, April 2016.

4 **Liferafts**

5 *El Faro* was required to carry three liferafts but had five on board (refer to Table 3). Four 25-man
6 liferafts were located on the boat deck, two on each side aft of the lifeboats, and a 6-man liferaft was
7 located on the bow. The two Viking 25-man liferafts onboard (liferaft 1, serial no. 25DK+10245946, and

1 liferaft 2, serial no. 25DK+10245947)⁴⁷ were both manufactured in October 2005 and both were visually
2 inspected on September 4, 2015. The technician noted on his report that the liferafts' necessary additional
3 pressure test, gas inflation test, and floor seam test were all within periodicity and that the liferafts were
4 not due for servicing until September 2016.

5 Vessels over 100 meters (328 feet) long are required by 46 CFR 199.261(e) to carry an extra
6 liferaft. *El Faro*'s 6-person liferaft was stowed forward on the main deck near the centerline so that it
7 could be picked up by two crewmembers and launched from either side. According to the ABS "Record
8 of Approved Cargo Ship Safety Equipment," the 6-person liferaft (No. 3) was a Swiftik Mk II liferaft
9 onboard (serial number 10). However, but according to current liferaft inspection records, the 6-person
10 liferaft actually on *El Faro* was a Viking liferaft (serial number 06DK+11355928) that was inspected on
11 May 18, 2015, and due for a 12-month inspection in May 2016 (figure 23 shows a Viking liferaft of the
12 type carried on *El Faro*). AMOS maintenance records show that the Swiftik liferaft was damaged by a
13 container on May 8, 2015, and then removed from the vessel.

⁴⁷ Viking Lifesaving Equipment Certificate of Re-Inspection Certificates no. 301344318 and 031344299, serviced by Liferafts Inc., of Puerto Rico, Base 464, dated September 4, 2015.



Figure 23. Viking throw-overboard liferaft, self-righting. (Viking life-saving equipment illustration)⁴⁸

The vessel carried two extra 25-person liferafts. According to TOTE, the extra liferafts were put onboard *El Faro* as a precaution after corrosion was found on the *El Yunque*'s gravity davits and in case a similar situation should arise on *El Faro*. Both liferafts were Elliot SOLAS Style Mk IV TO (liferaft 4, serial no. 5086300200735, and liferaft 5, serial no. 5086300200613).⁴⁹ The liferafts were manufactured in July 2015 and thus in their first 2 years of service. They were not due for service until July 7 and July 27, 2017, respectively. Figure 24 shows two stowed liferafts on the sister ship *El Yunque*.

⁴⁸ Viking Liferafts Catalogue p. 8, downloaded November 10, 2016, at admin.sds.viking-life.com/

⁴⁹ Survitec Group Certificate of Manufacture of inflatable liferaft, references 232808 and 232809.



Figure 24. Two liferafts stowed in cradles aft of *El Yunque's* number 2 (port) lifeboat.

A partially inflated liferaft was discovered during the SAR operation on October 4 at 23°29.2' N, 073°35.3' W. The liferaft was searched by a Coast Guard rescue swimmer for survivors or remains. None were found. The liferaft was confirmed to be from *El Faro* and was sunk to prevent being rediscovered by the crew of the cutter *Northland*. A second liferaft was reported at position 23°24.7' N, 073°54.9' W but could not be relocated. None of the five *El Faro* liferafts were recovered and none are located in the stowed positions on the wreckage.

Life Preservers (Lifejackets)

According to the ABS record of approved cargo ship safety equipment, *El Faro* had on board 46 Safegard Corporation, Model 3 190 or 190RT adult life preservers equipped with whistle and light. The life preservers were stowed in crew accommodations and work spaces. Forty-one were located in crew

cabins and the rest in work areas, as follows: two on the navigation bridge, two in the engine room control station, and one on the bow. No life preservers were recovered during the recovery operation.

The minimum standard life preserver required to be carried on *El Faro* would have been a Coast Guard-approved inherently buoyant Type I PFD (commercial off-shore life preserver for SOLAS service; see figure 25). The life preserver is buoyant and designed to turn an unconscious adult's head in the face-up position above water. It is used for all waters, open ocean, rough seas, or remote water, where rescue may be slow in coming.⁵⁰



Figure 25. Coast Guard Type I PFD. (Mustang Survival illustration)⁵¹

A damaged work vest washed ashore on Bob Cay, Great Exuma Island, Bahamas, and was turned in to Coast Guard Sector Jacksonville in November 2015. When shown a photo of the work vest, the TOTE representative stated that it was not the type of PFD carried on any TOTE vessel. Three new Coast Guard Type II PFDs (near-shore buoyant vest for recreational use) were recovered (solid orange, red

⁵⁰ Coast Guard Life Saving & Fire Safety Division Commandant (CG-ENG-4) downloaded on November 10, 2016 at <https://www.uscg.mil/hq/cg5/cg5214/pfdselection.asp#top>

⁵¹ Mustang Survival Adult 4-One SOLAS Life Jacket Model Number MV8040 downloaded November 10, 2016 at <https://mustangsurvival.com/professional/mv8040?division=professional>

pattern, and black pattern). When shown photos of the PFDs, the TOTE representative stated that none were the PFD type used on TOTE vessels. The PFDs were determined to be cargo on *El Faro*.

Lifebuoys (Ring Buoys)

The vessel was equipped with thirty 30-inch orange lifebuoys. The lifebuoys were stowed in various locations throughout the vessel. Two with smoke floats were located on the bridge wings. The rest were located on the weather decks: 14 with no attachments, 2 with throwing line, 10 with attached lights, and 2 with buoyant line. Eight of the lifebuoys were recovered (see figure 26 and Tables 3 and 5). A smoke float was found on the ocean floor during the second VDR search (figure 27).



Figure 26. Recovered broken 30-inch lifebuoy stenciled *El Morro*, photographed in San Juan.

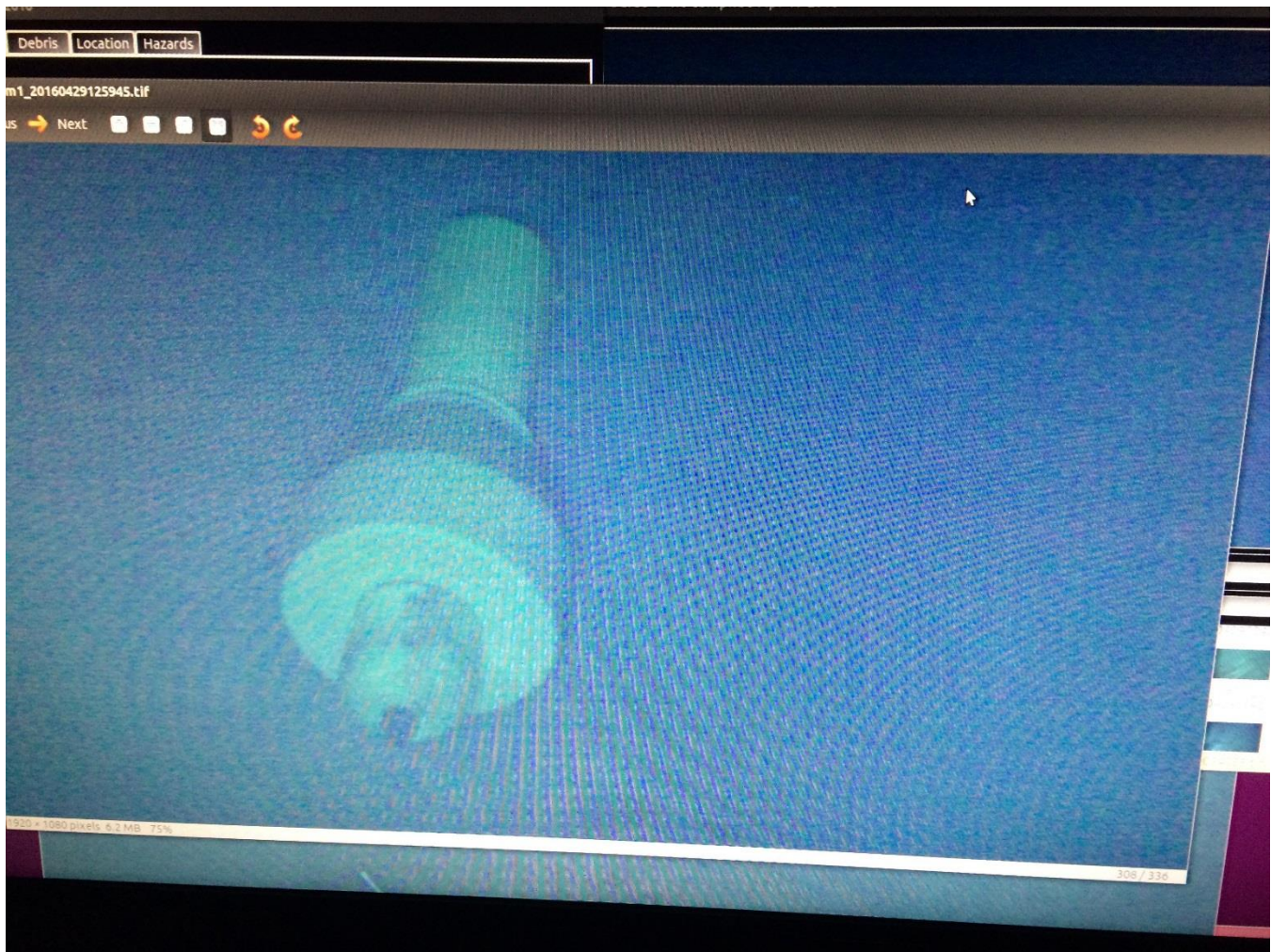


Figure 27. Smoke float on ocean floor found on second *El Faro* VDR search by vessel *Atlantis* in April 2016. TOTE's fire and safety plan shows lifebuoys and smoke floats on port and starboard bridge wings.

Immersion Suits

The vessel was outfitted with 52 to 56 immersion suits. The AMOS maintenance system shows a purchase order for 52 immersion suits for required 2-year inspection and pressure testing on August 14, 2015, and a purchase order for 4 oversize adult immersion suits. Two of *El Faro*'s immersion suits were recovered after the accident (see Tables 3 and 5). The immersion suit with the human remains that was discovered and investigated on October 4 was not recovered. Details of the discovery are listed above, under "SAR Day 4: October 4, 2015."

1 The first immersion suit was recovered on October 6 by the cutter *Charles Sexton*. The back of
2 suit was marked "SS El Faro San Juan, P.R." in white but appears to have been previously marked "El
3 Morro" in black. It was labeled "Imperial Manufacturing Co., Bremerton, WA 98310; Adult Universal
4 (more than 110 lbs); Model No. 1409; Serial No. 94797; Lot No. 348; Manufacture date 6-85."

5 The second immersion suit was recovered on October 7 by the *Charles Sexton* (figure 28). It was
6 found with whistle and strobe light (off and operational); unzipped, left arm inside out, tear at right hip
7 seam almost in half; back marked "S.S. El Faro San Juan, P.R." in white and appears to have been
8 previously marked "El Morro" in black. It was labeled "Imperial Manufacturing Co., Bremerton, WA
9 98310; Adult Universal (more than 110 lbs.); Model No. 1409; Serial No. 95015; Lot No. 351/6;
10 Manufacture date 6-85."

11 Another immersion suit was turned in to Coast Guard Sector Jacksonville, but when shown a photo
12 of the immersion suit, the TOTE representative stated that the type of immersion suit (it required a
13 lifejacket to be worn with it for flotation) was not carried on any TOTE ship.



1

2 **Figure 28.** Immersion suit found with whistle and strobe light (off and operational); unzipped, left arm
3 inside out, tear at right hip seam almost in half; back marked "S.S. El Faro San Juan, P.R." in white
4 appears to have been previously marked "El Morro" in black.

5 Details of survival debris from *El Faro* that were discovered during the SAR operation or in the
6 days or months afterward are given in Table 5. If the debris was recovered, details of the recovery are
7 included.

1

Table 5. *El Faro* survival debris discovered or recovered.

Survival Debris	Tag No.	Description
Starboard lifeboat	No tag	<p>Lifeboat 1 was sighted by air about 1500 on October 4, at 23-24.2N, 073-54.5W. Tug Hawk arrived at 1537 and found lifeboat heavily damaged, floating vertically with 2-3 ft of the bow above water. At 1552, a Coast Guard helicopter lowered its rescue swimmer onto tug Hawk. Rescue swimmer was in water from 1600 until 1616, inspecting lifeboat. Helicopter retrieved rescue swimmer at 1620 by hoisting him from tug's aft deck.</p> <p>The following damage was noted:</p> <p>Port bow was missing section of gunwale 61 in. long and 32 in. down toward keel.</p> <p>Port quarter was missing gunwale section 42 in. long and 33 in. down.</p> <p>Starboard quarter was missing 150-in. section of gunwale extending down to keel.</p> <p>Many sections of hull were cracked.</p> <p>Propeller was fouled with lines and a blade was bent.</p> <p>Bow and stern manual hook release handles were bent and inoperable.</p> <p>Rudder tiller was missing.</p> <p>Note: A deployed sea anchor was reported with lifeboat when it was delivered to Coast Guard Air Station Miami. NTSB investigator found a new Coleman ground cover used for camping, not a sea anchor.</p>
Port lifeboat	Dive S381 Contact 0153	<p>Lifeboat 2 found on ocean floor by autonomous underwater vehicle (AUV) <i>Sentry</i> at position 23° 23.5'N, 073° 54.5'W</p> <p>One end of lifeboat was cut off.</p>
Liferaft	N/A	<p>Discovered 2057 UTC on October 4 at 23-29.2N, 073-35.3W by cutter <i>Northland</i>. Searched and found empty, then sunk.</p> <p>Second reported liferaft, reported at 1657 on October 4 by Navy P-8 at 23-24.7N, 073-54.9W, could not be relocated.</p>
Immersion suit – 1 of 3; with human remains	N/A	<p>Found 2047 UTC on October 4 at 23°25.6'N, 074°11.8'W.</p> <p>Investigated, but when helicopter was called away, could not be reacquired.</p>
Immersion suit – 2 of 3	176809	Recovered 2306 UTC on October 6 at 24-03.8N, 073-14.1W by cutter <i>Charles Sexton</i> (WPC 1108).
Immersion suit – 3 of 3	176812	Recovered 1603 UTC October 7 at 23-58.9N, 073-19.5W by cutter <i>Charles Sexton</i> (WPC 1108).
Lifebuoy – 1 of 8	No tag	Recovered by <i>El Yunque</i> and passed to cutter <i>Northland</i> for transfer to Coast Guard Sector Jacksonville.
Lifebuoy – 2 of 8	No tag	Stenciled "El Faro"; damaged DATREX label; missing circular plastic plug for inserting floatation material.

Survival Debris	Tag No.	Description
Lifebuoy – 3 of 8	176808	Recovered 1810 UTC on October 6 at 24-05.9N, 073-25.6W by cutter <i>Charles Sexton</i> . DATREX buoy broken in half; stenciled “El Morro San Juan, PR.”
Lifebuoy – 4 of 8	197131	Recovered October 5 at 24-37.6N, 073-03.3W by cutter <i>Resolute</i> (WMEC 620). Stenciled “El Faro”; DATREX Inc. Kinder LA Commercial Ring Buoy Type IV PFD; Model No. DX03250; Deck Buoy; Issue No. E-843; Lot No. 822; Insp. 12-08; MFG date 11-08.
Lifebuoy – 5 of 8	197132	Recovered October 5 at 24-37.2N, 073-03.7W by cutter <i>Resolute</i> (WMEC 620); Stenciled “El Morro”; damaged – torn and missing circular plastic plug for inserting floatation material; embossed DATREX Buoy.
Lifebuoy – 6 of 8	197134	Recovered October 5 at 24-38.3N, 073-01.8W by cutter <i>Resolute</i> (WMEC 620). Stenciled “El Faro”; damaged label reads “No. E-122” and “2002”; same label format as DATREX deck buoy.
Lifebuoy – 7 of 8	197135	Recovered October 5 at 24-38.4N, 073-01.2W by cutter <i>Resolute</i> (WMEC 620). Stenciled “El Far”; DATREX Inc. Kinder LA USA; issue No. E-843; lot No. 711; MFG date 12-04; Insp. 12-04.
Lifebuoy – 8 of 8	No tag	Recovered around November 11 on Man-O-War Cay, Abaco Island, Bahamas, at about 26°-35.9'N, 077°-00.2'W, by beachcomber. Stenciled “El Faro”; DATREX Inc. Kinder LA USA.
Smoke float – 1 of 2	No tag	Recovered by cutter <i>Charles Sexton</i> (WPC 1108).
Smoke float – 2 of 2	Dive S385	Found on ocean floor by AUV <i>Sentry</i> at position 23° 23.2'N, 073° 54.6'W.

1

2 Electronic Survival Equipment

3 *El Faro* carried several electronic devices that would transmit location data or emergency signals.

4 Since it was not possible to investigate the interior of the sunken vessel to determine where *El Faro*'s

5 electronic survival equipment might have been located, NTSB investigators examined *El Faro*'s sister

6 ship *El Yunque*. Figure 29 shows the location of the SART beacon, GMDSS radios, and extra batteries on

7 the bridge of *El Yunque*.



Figure 29. Pictured on *El Yunque*'s bridge are from left, orange 9 GHz (SART) beacon, three 2-channel VHF GMDSS survival (lifeboat) radios, and extra batteries below.

5.6. Maintenance of Lifesaving Gear

Maintenance was tracked by a "Safety Inspection and Equipment Testing Log" spreadsheet maintained onboard *El Faro*.⁵² TOTE had a planned maintenance system for the vessel's equipment called AMOS. According to *El Faro* maintenance records for 2015, planned maintenance on the lifesaving gear was completed by *El Faro*'s crew as shown in Table 6. Note that crewmembers had to manually enter the records.

⁵² NTSB transcript of interview of *El Faro* off-duty third mate taken in Jacksonville on December 6, 2015, pp. 10-11.

1

Table 6. Scheduled maintenance of life-saving equipment by *El Faro* crew during 2015.

Maintenance Task	Frequency	Date Completed
<i>Port Lifeboat</i>		
Test engine	Weekly	January 1, 8, 15, 25, 29 February 5, 14, 19, 26 March 1, 5, 12 April 2, 9, 17, 30 May 7, 14, 21, 28 June 4, 11, 20, 25 July 2, 9, 16, 23, 30 August 6, 13, 29 September 27
Inspect	Monthly	January 8 February 19 April 3 May 28 June 28
Grease davit-releasing gear	Monthly	January 31 February 9 February 27 April 17 June 5 July 24
Test releasing gear	3 months	January 9 April 17 July 24
Lubricate wire rope (falls)	3 months	February 27 May 30
Check davit limit switch	6 months	February 14
Test lifeboat weight	12 months	January 27
Strip and clean	12 months	April 12
Service diesel engine	12 months	July 30
Renew fuel oil	12 months	July 30
Renew gear case oil	12 months	July 30
<i>Starboard Lifeboat</i>		
Test Fleming gear	Weekly	January 1, 8, 15, 22, 30 February 5, 14, 19, 26 March 5, 12 April 2, 9, 16 May 7, 14, 21, 28 June 4, 11, 20, 25 July 2, 9, 16, 23, 30 August 13, 29 September 27

Maintenance Task	Frequency	Date Completed
Inspect	Monthly	January 8 February 19 March 28 April 30 May 28 June 28
Grease davit-releasing gear	Monthly	January 31 March 20 June 5

SOURCE: AMOS maintenance records dated October 7, 2015.

The company submitted purchase order records of maintenance performed by contractors. According to *El Faro* purchase orders for 2015, contractors completed surveys, inspections, and maintenance on *El Faro*'s lifesaving equipment as shown in Table 7.

Table 7. Safety-related *El Faro* purchase orders for contracted work maintenance (2015).

Description of Work	Purchase Order No. Vendor	Date of Issue
Lifeboat davits and releasing system: Harding to service and certify port and starboard davits and release systems.	EFOE150097 Harding Safety (formerly Umoe Schat)	Undated
Port lifeboat: make up a set of hoses for the motorized lifeboat.	EFOE150116 Hose Power USA	11-Sep-2015
Port lifeboat – technician to attend <i>El Faro</i> to replace clutch mechanism on port and starboard life boat davits. Certify safe operation of each.	EFOE150128 Harding Safety (formerly Umoe Schat)	Undated
Lifeboats: purchase of two lifeboat DATREX first aid kits meeting Coast Guard approval. Equivalent to annual inspection (MA10-1118). Purchase of 1,776 (125 ML) packets of Kinder emergency drinking water to meet Coast Guard approval.	EFOE150115 Liberty Marine Services, Inc.	01-Jun-2015
Lifeboats: purchase of 12 lifeboat drain plug balls.	EFOE150155 Harding Safety (formerly Umoe Schat)	26-Jun-2015
Liferaft: required hydrostatic release and annual inspection of two 25-man liferafts, SN DK10245946 and DK10245947.	EFD150166 Liferafts of Puerto Rico	01-Sep-2015
Liferaft: repair or replace bow mounted 6-man liferaft damaged by container 5/08 in Puerto Rico.	EFOE150061 Liferafts of Puerto Rico	Undated

Description of Work	Purchase Order No. Vendor	Date of Issue
Liferaft: purchase of a Hammar H20 hydrostatic release that is Coast Guard certified.	EFOE150036 Liferafts of Puerto Rico	19-Feb-2015
Two 25-man liferafts for back up in case of davit non-compliance.	EFOE150112 SURVITEC Survival Products	28-Jul-2015
Ring buoys: purchase of 12 lantern batteries for lifering water lights (6 volt).	EFOE150184 Liberty Marine Service, Inc.	27-Jul-2015
52 immersion suits: required 2-year inspection and pressure testing.	EFD150201 Liferafts of Puerto Rico	14-Aug-2015
Immersion suits: purchase of 4 adult oversize immersion suits.	EFD150219 No vendor listed	19-Aug-2015
Radio – coded for maintenance.	EFOE 150030 Hasty's Communications of Florida, Inc.	Undated
INMARSAT blanket purchase order.	EFOE150027 INMARSAT	Undated
GMSDD – coded for vessel maintenance.	EFOE 150024 IMTECH Marine USA, Inc.	Undated
Riders – JMR to supply two helpers to ride the ship for one week 7/21 to 7/27 to assist crew in conversion work as directed by company technical advisor – coded for <i>El Faro</i> Alaska conversion.	EFOE150103 Jacksonville Machine & Repair, Inc.	Undated

1 NOTE: According to TOTE, undated purchase orders were issued verbally.

2

3 ABS provided information for required tests and inspections of *El Faro*'s lifeboats (Table 8).

4 **Table 8.** Last required weight tests of lifeboat davits and brakes and renewal of fall wires.

Lifeboat System Test	Reference	Date
Full weight test: Last 5 year full load (1.1 X SWL) test of davit and brake was completed.	ABS Mobile, AL report no. M1926092, dated 29-Jan-2011.	27-Jan 2011
Light weight test: Last lightweight (brake test) and annual thorough examination per SOLAS regulation III/20.11.2.2 of the lifeboat and Rottmer type releasing gear was verified at the last Annual Safety Equipment Survey 4.	ABS San Juan, PR, report no. SJ2784122, dated 09 Jan 2015 (Questions 17 and 18 on the survey checklist, MBI exhibit 229).	09 Jan 2015
Lifeboat fall wires renewal: Last 5-year interval. (NOTE: Per SOLAS and Coast Guard	ABS Mobile, AL report no. M1926092	01-Jan 2011

requirements, end-for-ending is no longer an option. Falls are to be renewed at 5 year intervals.)		
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5.7. COI Manning

According to its COI, the manning requirements for *El Faro* were as shown in Table 9.

Table 9. *El Faro* manning requirements in COI issued February 22, 2011.

Number	Billet / Notes
1	Master
1	Chief Mate
1	2nd Mate / OICNW (Officer in Charge of a Navigational Watch)
1	3rd Mate / OICNW
6	Able Seamen / ROANW (Rating Forming Part of a Navigational Watch)
1	Chief Engineer
1	1st Assistant Engineer / 2nd Engineer
1	2nd Assistant Engineer / 3rd Engineer
1	3rd Assistant Engineer
3	Oilers
	Note: Included in which there must be 5 certified lifeboat men and 3 GMDSS operators.
	This vessel may carry: 16 other persons in crew; 9 persons in addition to the crew.
	Total persons allowed: 42

5.8. Station Bill

TOTE did not have a copy of *El Faro*'s station bill. On October 10, 2015, investigators photographed *El Yunque*'s station bill, which assigned duties to each person on board in case of emergency and also assigned them to lifeboats. *El Yunque*'s station bill is reproduced in Table 10.

1

Table 10. *El Yunque* station bill for fire and emergency and abandon-ship duties.

Rating	Billet	Fire and Emergency	Boat	Abandon Ship
MASTER	1	Bridge, In Command	1	Bridge, In Command
CHIEF MATE	2	Emergency Party (EP) Leader / In Charge at Scene	2	LB #2, In Command
2 ND MATE	3	Support Party (SP) / In Charge	1	LB #1, In Command / SART
3 RD MATE	4	Bridge, Relieve Watch / Global Maritime Distress and Safety System (GMDSS)	2	LB #2 AOIC / SART / EPIRB
BOSUN	5	EP / Hose Team Leader	1	Brake /Ready to Launch
Able Seaman (AB) WATCH #1	6	*** EP / Self Contained Breathing Apparatus (SCBA) /Hoseman / Asst	2	Assist as Directed
AB WATCH #2	7	*** EP / SCBA /Hoseman / Asst	1	Tend Fwd Gripe / Frapping Line
AB WATCH #3	8	*** EP / SCBA /Hoseman / Asst	2	Tend Fwd Gripe / Frapping Line
AB MAINT #1	9	EP / SCBA / Nozzleman / Asst	1	Tend Aft Gripe / Frapping Line
AB MAINT #2	10	EP / SCBA / Nozzleman / Asst	2	Tend Aft Gripe / Frapping Line
General Utility, Deck and Engine (GUDE) – DECK #1	11	EP / Hydrant Man / Asst	1	Secure Boat Plug
GUDE – DECK #2	12	EP / Hydrant Man / Asst	2	Assist as Directed
DECK CADET #1 (Vacant)	13	EP / Assist as Directed	1	Assist as Directed
DECK CADET #2 (Vacant)	14	EP / Assist as Directed	2	Assist as Directed
CHIEF ENGINEER	15	Engine Room (E/R), In Charge	1	Maintain / Operate Clutch
1 ST ENGINEER	16	EP / 2 nd in Charge	2	Start / Operate Engine
2 ND ENGINEER	17	E/R, Assist Chief Engineer	1	Assist as Directed
3 RD ENGINEER #1	18	Fire Control Rm / CO2 Room	2	Assist as Directed

Rating	Billet	Fire and Emergency	Boat	Abandon Ship
3 RD ENGINEER #2	19	EP / Set Fire Boundaries	1	Assist as Directed
ELECTRICIAN	20	EP / Start Emergency Diesel Generator (EDG) as Directed	1	Brake / Ready to Launch
OILER MAINTENANCE UTILITYMAN (OMU) #1	21	EP / SCBA /Hoseman / Asst	2	Tend Sea Painter
OMU #2	22	EP / SCBA /Hoseman / Asst	1	Tend Sea Painter
OMU #3	23	EP / SCBA /Hoseman / Asst	2	Tend Sea Painter
GUDE – ENGINE	24	EP / Hydrant Man / Asst	1	Secure Boat Plug
ENGINE CADET #1 (Vacant)	25	EP / Assist as Directed	2	Assist as Directed
ENGINE CADET #2 (Vacant)	26	EP / Assist as Directed	1	Assist as Directed
STEWARD	27	SP / Muster Supernumeraries	2	Assist Supernumeraries
CHIEF COOK	28	SP / Assist as Directed	1	Assist Supernumeraries
STWD ASST	29	SP / Assist as Directed	2	Assist Supernumeraries
SUPERNUMERARY	30	Emergency Gear Locker	1	Assist as Directed
SUPERNUMERARY	31	Emergency Gear Locker	2	Assist as Directed
SUPERNUMERARY	32	Emergency Gear Locker	1	Assist as Directed
SUPERNUMERARY	33	Emergency Gear Locker	2	Assist as Directed
SUPERNUMERARY	34	Emergency Gear Locker	1	Assist as Directed
SUPERNUMERARY	35	Emergency Gear Locker	2	Assist as Directed
SUPERNUMERARY (3 rd Engineer #3)	36	Emergency Gear Locker	1	Assist as Directed
SUPERNUMERARY Qualified Member, Engineering Department (QMED)	37	Emergency Gear Locker	2	Assist as Directed
*** NOTE: IF YOU ARE THE AB ON WATCH / HELM, THEN STAY ON WATCH / HELM FOR FIRE AND EMERGENCY				

5.9. Fire and Emergency

The signal for fire and emergency was one continuous blast of the ship's whistle and continuous ringing of the general alarm bells, both sounded for not less than 10 seconds, coupled with an announcement on the public address system. The fire and emergency command station was the bridge. The emergency gear locker was on the upper deck (galley deck) on the port side, inside the main house. Both the emergency party and the support party muster locations were at the emergency gear locker.

The signal for dismissal from drill from fire and emergency stations was three short blasts on the ship's whistle and the same on general alarm bells.

5.10. Abandon Ship

The signal to abandon ship was more than six short blasts followed by one long blast of the ship's whistle and the same on the general alarm bells. The signals used for handling boats were as follows:

- Lower boats – 1 short blast on ship's whistle,
- Stop lowering boats – 2 short blasts on ship's whistle, and
- Dismissal from boat stations – 3 short blasts on ship's whistle.

The manufacturer stipulated the following procedures for lowering *El Faro*'s lifeboats⁵³:

- (a) Remove boat cover-cap drain plug.
- (b) Release gripes and stopper bars. Clear them away. Important to swing stopper bars clear of trackways. Be sure they are secured in open position by the toggle pins. Otherwise the bars are liable to swing back on the trackways.

⁵³ Operating Instructions, p. 10 of Instruction Book, Type 26-15 Gravity Davit with Type 35G Mk II Winch for 26-foot Fiberglass Lifeboats; Sun Shipbuilding and Drydock Company, Chester, Pennsylvania, Sun Hull 674, Roll On/Roll Off Vessel; MASECO Book No. 9547/9555, Marine Safety Equipment Corporation, Farmingdale, New Jersey, November 1, 1975.

- (c) Raise brake handle. Check speed with hand brake and ease davit over side. Tricing pendant will bring lifeboat to ship's side.
- (d) Hold with frapping lines and release tricing pendant.
- (e) Load boat.
- (f) Ease off frapping lines.
- (g) Lower to water. Control operation with hand brake.
- (h) As the boat reaches the water level allow the winch to run out sufficient rope to permit releasing of the Rottmer release hooks. This is accomplished by throwing release handle in the boat.

The procedures for manually launching *El Faro*'s liferafts were as follows (as stated on a placard labeled "Inflatable Liferaft Launching Instructions" at *El Yunque* liferaft station 2):

- (a) Release the manual slip hook.
- (b) Check painter is made fast.
- (c) Throw liferaft into the sea.
- (d) Pull on the painter until the liferaft inflates then pull it to the ship's side.
- (e) Vital actions after launching.
 - a. Righting upturned liferaft.
 - b. Board quickly.
 - c. Move clear of the ship.
 - d. Stream the sea anchor.
 - e. Close the entrances.

The liferafts had an automatic underwater release in case the ship sank before they were launched:

- (a) Liferaft will be released and float upwards.
- (b) It will inflate and break free from the ship.
- (c) It will then float to the surface.

5.11. Safety Drills

US-registered vessels are required by 46 CFR 199.180(c)(2) to conduct monthly fire and boat drills. TOTE required weekly fire/emergency and abandon-ship drills, weather permitting. At the end of each month, the *El Faro* captain would review the deck logs and submit them all to TOTE. Deck logs for September 2015 had not been submitted to the TOTE office, because *El Faro* departed Jacksonville on September 29 and the vessel sank on October 1. According to past monthly submissions of *El Faro*'s deck logs, fire and boat drills were conducted during August 2015 on the 6th, 13th, and 20th.

The last verifiable fire drill was conducted on Thursday, August 27, at 1520. According to the log book, *El Faro* was then transiting the Old Bahama Channel to avoid wind and seas from Tropical Storm Erika. Beaufort wind scale 5 was entered in the deck log at 1500—a fresh breeze, winds 17-21 knots, and moderate waves 4-8 feet taking longer form, many whitecaps, some spray. According to an email stapled to the deck log page, the chief mate conducted a “table top fire/emergency drill” at 1520. All hands were mustered in the crew lounge and instructed in the procedures for fighting a Class A fire in the aft mooring line storage room. A muster was taken and reported to the bridge. The chief mate instructed the crew about setting fire boundaries, securing power and ventilation, and leading fire hoses from fire stations 32 and 33. Fire hose teams 1 and 2 did not don their fire-fighting suits.

The chief mate discussed the following with the crew: size of fire, potential for fire to spread, use of CO₂ extinguisher vs. dry chemical extinguisher, use of water fog, hose-handling techniques, use of portable aqueous film-forming foam extinguisher. The chief mate then discussed the importance of reporting fires and emergencies, how to overhaul a fire, and how to set a fire reflash watch. After the fire/emergency drill, the crew had International Safety Management (ISM)/Safety of Life at Sea (SOLAS)

1 training on the line-throwing appliance, TOTE harassment policy, hot work, and the monthly safety
2 meeting.

3 **5.12. Inspections.**

4 US-registered vessels are required by 46 CFR 199.190 to make certain weekly, monthly, and
5 annual inspections. Of interest in the August 2015 deck logs are the following entries:

- 6 • August 1: 0800 on, conducted daily deck department safety meeting: 8/1, 8/2, 8/3, 8/7, 8/8,
7 8/9.
- 8 • August 1: 0900, conducted monthly test of AED (automated external defibrillator), all sat.
- 9 • August 16 at 1050; August 30 at 0800, at sea, a deck log entry was made: “IAW SOLAS
10 Reg. III/120.6 Lifeboats #1 and #2 lowered to embarkation deck, raised and secured for
11 sea.”
- 12 • August 19 at 1600, logged at sea with position: “conducted the following monthly
13 inspections IAW TSJ-V-Deck-020 burn kits, eye wash stations, first aid kits and
14 Emergency Escape Breathing Device (EEBD)’s – all satisfactory.”
- 15 • August 13 at 1410; August 20 at 1050; August 27 at 1628, the captain made an entry in the
16 deck log: “at position...tested lifeboats radios (3), Search and Rescue Transponders
17 (SART) (2), 406mhz Emergency Position Indicating Radiobeacon (EPIRB). All
18 satisfactory per 46CFR190.190(e)(2).”

- August 22 at 1500, a deck log entry was made: “at position...IAW CFR 46/97.15-60 and 46/91.35-1 completed monthly inspection of emergency gear lockers, Hazardous Material (HAZMAT), and Self Contrained Breathing Apparatus (SCBA)’s.”

5.13. Monthly Safety/Security and ISM Meeting

El Faro conducted its last monthly safety meeting from 1520 until 1542 on September 24, while at sea. The meeting was attended by the senior crewmembers: captain, chief mate, second mate/ship’s security officer, bosun, chief engineer, first assistant engineer, chief steward, and chief electrician. The meeting started with a review of the previous safety meeting’s minutes, which included using personal protective equipment (PPE) during all docking and cargo operations; gangway security requirements in the vessel’s security plan; and TOTE’s second quarter safety/security/environmental newsletter on restricted work injuries, near misses, and safety alerts.

New business discussed included TOTE’s zero-tolerance policy; TOTE’s portable communication devices policy that cell phones are not intrinsically safe; the effect of stateroom lights with curtains left open at night on the bridge watch team’s night vision; the importance of reporting all medical treatment injuries; notifying the mate on watch at sea when entering the lifeboats for inspections/maintenance and wearing PPE; reminding crewmembers to be considerate to their shipmates around accommodation spaces—music, talking, and not slamming stateroom doors; the chief mate emphasized wearing a safety harness while deploying the ship’s gangway; and the second mate discussed the watchstanding able seaman’s gangway duties and responsibilities. Finally, the ship’s safety committee members noted that all ISM manuals were available in the captain’s office and on the ship’s network computer for all crewmembers to review.

5.14. Supernumeraries

According to the station bill, the supernumeraries' fire and emergency station was at the emergency gear locker (starboard side, aft on main deck, under superstructure). For abandon ship, each supernumerary was assigned to a lifeboat (about half to lifeboat 1 and half to lifeboat 2), with the duty to assist as directed. The crew mess was the muster station for supernumeraries for man overboard and steering casualty events.

In interviews with off-duty crewmembers, it could not be determined whether the supernumeraries mustered for fire and emergency stations or for abandon-ship drills. It was thought that the supernumeraries mustered at the crew mess for drills. The interviewed off-duty crewmembers said that one of the Polish supernumeraries spoke English and that he would get instructions in English and translate them into Polish for the other Polish supernumeraries.

The TOTE Operations Manual—Vessel Shipboard Policy (OMV-3), Section 3.4.1 “Engineering—Responsibility for: Contractors, Riding Gangs & Surveyors” stated that members of a riding gang should typically report to the chief engineer. The fifth paragraph of page 27 in the manual stated:

All members of a riding gang shall be given an indoctrination tour of the vessel before or as soon after sailing as possible. Form TSI-V-SAF-023 has been prepared to assist the crew with indoctrination of on board contractors. The indoctrination / orientation shall be noted on the log sheet [TSI-V-ADM-038] before work is started. All riders, embarked guests and contractor supervisors must receive this training and sign the log sheet.

1 The TOTE Operations Manual—Vessel Forms Addendum (FORMS–LOC) lists safety
2 indoctrination guidelines (noncrewmember/contractors) (TSI-V-SAF-023) revised in April 2014. The
3 guideline lists the following safety topics to be covered for all noncrewmembers, riders, and contractors:

- 4 • Emergency alarm—locations, procedures, emergency escape routes.
- 5 • Emergency muster locations.
- 6 • Locating and donning lifejackets/survival suits; locations—emergency locker and self-
7 contained breathing apparatus.
- 8 • Location—hospital; photography restrictions – master’s policy.
- 9 • Policies—PPE/footwear, safety, drug and alcohol.
- 10 • Portable fire extinguisher use.
- 11 • Security level (prevailing) procedures.
- 12 • Telephone system.
- 13 • Waste disposal procedures;
- 14 • Work and meal hours.
- 15 • Accidents/injuries and near-misses to be reported immediately to a vessel representative.
- 16 • Consequences of violating policies.
- 17 • Enclosed space entry.
- 18 • Hazmat handling: storage/disposal.
- 19 • Hot work procedures and fire watch.
- 20 • Lock-out/tag-out.
- 21 • Machinery operating restrictions.
- 22 • Responsibility for employees.
- 23 • Review of the work area.
- 24 • Taking immediate action before raising the alarm (master’s policy).

25 The same topics (and more) are covered in the deck, engine, and steward department indoctrination
26 guidelines.

1 TOTE addendum TA-12 states that completed indoctrination logs were to be kept onboard the ship
2 for 2 years and that a copy of the logs was to be sent to the operations department each quarter for the
3 deck department, engine department, steward department, and noncrewmembers. Copies of the signed
4 indoctrination logs were to be turned in quarterly by the company's vessels.

5 Signed indoctrination logs were provided by TOTE for the deck, engine, and steward departments
6 and noncrewmembers for the fourth quarter (October 1 to December 31) of 2014 and for the first quarter
7 (January 1 to March 31) and the second quarter (April 1 to June 30) of 2015. The signed indoctrination
8 logs for noncrewmembers show numerous signatures for rider techs, cowboys (animal caretakers), deck
9 cadets, engine cadets, cadet observers, and port mates.

10 The Polish supernumeraries first came on board during the third quarter (July 1 to September 30)
11 of 2015 on or about August 16. *El Faro*'s accident voyage began in the final days of the third quarter of
12 2015, on September 29.

13 **5.15. Position by EPIRB—Unlocated First Alert**

14 *El Faro* was equipped with a non-GPS encoded, 406-MHz EPIRB. The EPIRB was detected at
15 0736 on October 1 and a "406 beacon unlocated first alert" was sent at 0739 from the USMCC to D7CC.⁵⁴

16 *El Faro*'s EPIRB was detected by the GEOSAR system for 24 minutes from 0735 to 0759. Two
17 low earth orbit (LEO) satellite passes are required to generate a position. No LEO satellite passes occurred
18 while *El Faro*'s EPIRB was transmitting. Therefore, no location could be determined.

⁵⁴ Information in this section comes from transcripts and errata of NOAA SARSAT senior space systems engineer interview on March 4, 2016, at NOAA Satellite Operations Facility in Suitland, Maryland, and its accompanying report: *US SARSAT Engineering report of MV El Faro incident, Oct. 1, 2015*.

1 With the LEO system, the EPIRB needed to transmit for 30 minutes for a “406 beacon unlocated
2 second alert” to be sent (if no position could be determined before 30 minutes had passed). The EPIRB
3 detections stopped after 24 minutes.

4 A non-GPS-encoded EPIRB position can be determined by LEO satellites with an accuracy of
5 between 2 to 5 km (1.25 to 3 miles), but can be delayed up to 2 hours,⁵⁵ depending on the EPIRB location,
6 the time of EPIRB activation, and LEO satellite geometry.

7 The position transmitted by a GPS-encoded EPIRB, available since 1998, is theoretically accurate
8 to within 7.8 meters (25.6 feet) on the first transmission.⁵⁶

9 **5.16. EPIRB Positioning by Medium Earth Orbit Satellites**

10 Medium earth orbit (MEO) satellites are the GPS satellite constellation for the US that has been in
11 orbit for 20 years. As of the date of this report, NOAA, the Air Force, the Coast Guard, and the National
12 Aeronautics and Space Administration were working together on an experimental MEO search and rescue
13 system (MEOSAR).⁵⁷ The experimental system was not operational at the time of the *El Faro* accident,
14 and therefore data were not processed by NOAA’s USMCC for automatic 24/7 distress alerting during
15 the accident.

16 On learning of the accident, NOAA engineers analyzed MEOSAR data and found that:

⁵⁵ *Emergency Position Indicating Radiobeacon (EPIRB)*, US Coast Guard Navigation Center, downloaded October 27, 2016 from <http://www.navcen.uscg.gov/?pageName=mtEpirb>

⁵⁶ *GPS Accuracy*, GPS.GOV, downloaded October 27, 2016 at <http://www.gps.gov/systems/gps/performance/accuracy/>

⁵⁷ Information in this section comes from Transcripts and errata of NOAA SARSAT Senior Space Systems Engineer interview on March 4, 2016, at the NOAA Satellite Operations Facility in Suitland, Maryland and its accompanying report *US SARSAT Engineering report of MV El Faro incident, Oct. 1, 2015*.

- Two US MEO ground stations (Hawaii and Miami) each received 13 bursts (once every 50 seconds) from *El Faro*'s EPIRB during the 24 minutes the EPIRB was transmitting.
- Four MEO satellites received bursts from *El Faro*.
- The MEOSAR ground stations produced a position and reported it about 1 minute before the GEO satellite report.

The MEOSAR system was scheduled to commence early operations, passing distress detections and locations, in almost real time to Air Force and Coast Guard RCCs on November 15, 2016. A single EPIRB burst received by four MEO satellites will generate a position with an accuracy of within 5 km (3 miles).

As of the date of this report, the US had 18 MEO satellites in orbit. The European Union's Galileo system had 5 satellites with SAR packages, with 4 more scheduled to go into operation in 2016. The MEOSAR system is expected to be fully operational in 2018, with 70 MEO SARSATs (24 US, 24 European Union, and 28 Russian).

5.17. International Lifeboat Standards and Regulations

Design differences between old and current lifeboats are separated by the 1983 amendments to SOLAS 1974, effective July 1, 1986. The Harding Safety USA design team provided the information in Table 11.

Table 11. Lifeboat design criteria before and after SOLAS amendments took effect.

Design Criterion	Former (Before July 1, 1986) Open Lifeboats	Current (Since July 1, 1986) Fully-Enclosed Lifeboats
Maximum wind speed for launching lifeboat	No requirement for maximum wind.	No requirement for maximum wind.
Maximum sea state for launching lifeboat	No requirement for maximum seas.	No requirement for maximum seas.
Maximum list	Capable of being safely launched under all conditions of list of up to 15° either way (inboard or outboard).	Capable of being safely launched under all conditions of list of up to 20° either way (inboard or outboard).
Maximum trim	Capable of being safely launched under all conditions of trim of up to 10° either way (forward or aft).	Capable of being safely launched under all conditions of trim of up to 10° either way (forward or aft).

El Faro was inspected and surveyed in accordance with the SOLAS regulations applicable to the vessel based on its build date (1975). A vessel is surveyed under those regulations for the life of the ship or until it undergoes a major alteration. If the vessel undergoes a major alteration, it must comply with the (new) SOLAS regulations at the time of the major alterations.⁵⁸

The vessel was built with two open lifeboats—one mechanically propelled by Fleming gear (starboard) and one motor-propelled by a diesel engine (port), boarded at an embarkation deck. The motor lifeboat was the ship's rescue boat. Because the Coast Guard did not treat the 2006 conversion of *El Faro* from a roll-on/roll-off (Ro/Ro) to a Ro/Con configuration as a "major conversion," open lifeboats were permitted to remain on the vessel. The outfitting of *El Faro* with open lifeboats was based on SOLAS regulations that applied according to the vessel's date of build, rather than to the date of its conversion.⁵⁹

⁵⁸ Transcript of March 22, 2016, interview of retired Coast Guard chief, Lifesaving and Fire Safety Division, pp. 14-15.

⁵⁹ Coast Guard and TOTEM Ocean Trailer Express, Inc., eight letters regarding reconsideration of major conversion determination, February 1, 2002, through November 8, 2004.

Many modern Ro/Ro and Ro/Con ships are built with a single freefall lifeboat at the stern of the vessel, which is stowed in the ready-to-launch position and requires fewer steps to launch than side-launched lifeboats.⁶⁰ Only one stern-launched freefall lifeboat is required, compared with the two required conventional side-launched lifeboats. Both davit-launched and freefall lifeboats are required to safely launch under conditions of 20° of list and 10° of trim. In addition, freefall lifeboats are required to have a secondary means of launch that can safely launch in conditions of 5° of list and 2° of trim.⁶¹ The secondary means is used as a controlled way of lowering a freefall lifeboat in the water for quarterly tests.

According to the Coast Guard, as of October 7, 2016, there were 252 US-inspected vessels equipped with lifeboats (Table 12). Considering the post-1986 amendment standards, 72 vessels were equipped with side-launched fully enclosed lifeboats, and 34 were equipped with stern-launched freefall life capsules. A total of 146 vessels that hold valid COIs were equipped with side-launched open lifeboats (grandfathered to pre-1986 amendment standards).

Table 12. Survival craft systems on US-inspected vessels (07-Oct-2016 USCG).

Type of Survival Craft	Number of Vessels	Percent
Pre-1986 open lifeboats, side-launched	146	58
Post-1986 enclosed lifeboats, side-launched	72	29
Enclosed life capsules, freefall-launched	34	13
Total US-inspected vessels	252	100

The 1983 SOLAS amendments modernized many lifesaving requirements and came into effect for cargo ships constructed on or after July 1, 1986. Chapter III, “Life-saving Appliances and Arrangements,”

⁶⁰ *Implementation of Free-Fall Lifeboats on Ships*, James K. Nelson et al., *Marine Technology*, Vol. 31, No. 4, October 1994, pp. 269-277. Society of Naval Architects and Marine Engineers, Alexandria, Virginia (downloaded from <http://www.sname.org/pubs>).

⁶¹ 46 CFR 199.150(c), SOLAS III/16, and 46 CFR 160.132, which incorporates the requirements of the International Maritime Organization’s Life-Saving Appliance Code, Chapter IV.

1 was completely rewritten. The chapter in the 1974 SOLAS convention differed little from the text in the
2 1960 and 1948 conventions. The amendments were designed not only to take into account technical
3 advances since then but also to expedite the evaluation and introduction of further improvements.⁶²

4 Open lifeboats were no longer allowed on new-build vessels. The 1983 SOLAS amendments
5 allowed a relaxation of this prohibition, which was in effect until July 1, 1998:

6 *Administration may, however, permit cargo ships (except oil tankers, chemical tankers and*
7 *gas carriers) operating under favorable climatic conditions and in suitable areas, to carry*
8 *lifeboats complying with the requirements of reg. 43 [Self-righting partially enclosed*
9 *lifeboats].*⁶³

10 For major modifications or repairs, the 1983 amendments state that:

11 *For ships constructed before 1 July 1998, the Administration shall...ensure that when life-*
12 *saving appliances or arrangements on such ships are replaced or such ships undergo*
13 *repairs, alterations or modifications of a major character which involve replacement of,*
14 *or any addition to, their existing life-saving appliances or arrangements, such life-saving*
15 *appliances or arrangements, in so far as is reasonable and practicable, comply with the*
16 *requirements of this chapter. However, if a survival craft other than an inflatable liferaft*
17 *is replaced without replacing its launching appliance, or vice versa, the survival craft or*
18 *launching appliance may be of the same type as that replaced.*⁶⁴

⁶² International Maritime Organization. SOLAS 1974: Brief History - List of amendments to date and where to find them. Downloaded on August 31, 2016 <http://www.imo.org/en/KnowledgeCentre/>.

⁶³ International Convention for the Safety of Life at Sea, 1974, Concluded at London on 1 November 1974, Resolution MSC.6(48) adopted on 17 June 1983, Section III. Cargo Ships (Additional Requirements), Regulation 26. Survival Craft and Rescue Boats, pp. 315-316. Downloaded August 31, 2016: <https://treaties.un.org/>.

⁶⁴ Ibid. SOLAS 1983 amendment, p. 301.

Regulation 41, “General Requirements for Lifeboats,” contains the following new requirements on access to lifeboats:

*Every cargo ship lifeboat shall be so arranged that it can be boarded by its full complement of person in not more than 3 minutes from the time the instruction to board is given. Rapid disembarkation shall also be possible...The lifeboat shall be so arranged that helpless people can be brought on board either from the sea or on stretchers.*⁶⁵

Manually propelled lifeboats are no longer allowed by the 1983 SOLAS amendments, as stated in the section on lifeboat propulsion:

*Every lifeboat shall be powered by a compression ignition engine.*⁶⁶

A new-build ship cannot use an open lifeboat as a rescue boat. The lifeboat used as a rescue boat requires additional equipment, and the required davit-hoisting speed is different. A regulation allowing a lifeboat to be designated as the rescue boat (provided it meets rescue boat requirements), was also adopted by the 1983 amendments.

Gravity davits are allowed to launch lifeboats as long as they meet the latest life-saving appliance and SOLAS requirements when installed. Only minor updates applicable to *El Faro* have been made in life-saving appliance requirements since SOLAS was amended.

As adopted by the 1983 amendments, lifeboats are to be boarded in the stowed position. The 1983 amendments to SOLAS adopted the following regulation for cargo ships (Regulation 28, “Survival Craft Embarkation and Launching Arrangements”):

⁶⁵ Ibid. SOLAS 1983 Amendments, Regulation 41. General Requirements for Lifeboats, 3. Access into lifeboats pp. 332.

⁶⁶ Ibid. SOLAS 1983 Amendment, 6. Regulation 41. General Requirements for Lifeboats, Lifeboat propulsion 6.1, p.333.

1 *Cargo ship survival craft embarkation arrangements shall be so designed that lifeboats*
2 *can be boarded and launched directly from the stowed position and davit-launched*
3 *liferafts can be boarded and launched from a position immediately adjacent to the stowed*
4 *position or from a position to which the liferaft is transferred prior to launching in*
5 *compliance with the requirements of regulation 13.5.⁶⁷*

6 A SOLAS regulation applicable to *El Faro* is found in Chapter III, “Life-Saving Appliances And
7 Arrangements,” part A, General, Regulation 1, “Application”:

8 1. Unless expressly provided otherwise, this chapter shall apply to ships the keels of which are
9 laid or which are at a similar stage of construction on or after 1 July 1998.

10 2. For the purpose of this chapter, the term a similar stage of construction means the stage at
11 which:

12 .1. construction identifiable with a specific ship begins; and

13 .2. assembly of that ship has commenced comprising at least 50 tons or 1% of the estimated mass
14 of all structural material, whichever is less.

15 3. For the purpose of this chapter:

16 .1. the expression ships constructed means ships the keels of which are laid or which are at a
17 similar stage of construction;

18 .2. the expression all ships means ships constructed before, on or after 1 July 1998; the
19 expressions all passenger ships and all cargo ships shall be construed accordingly;

20 .3. a cargo ship, whenever built, which is converted to a passenger ship shall be treated as a
21 passenger ship constructed on the date on which such a conversion commences.

⁶⁷ Ibid. SOLAS 1983 amendments, Section III, Cargo Ships (Additional Requirements), regulation 28, “Survival Craft Embarkation and Launching Arrangements,” p. 318.

1 4. For ships constructed before 1 July 1998, the Administration shall:

2 .1. ensure that, subject to the provisions of paragraph 4.2, the requirements which are applicable
3 under chapter III of the International Convention for the Safety of Life at Sea, 1974, in force
4 prior to 1 July 1998 to new or existing ships as prescribed by that chapter are complied with; and

5 .2. ensure that when life-saving appliances or arrangements on such ships are replaced or such
6 ships undergo repairs, alterations or modifications of a major character which involve
7 replacement of, or any addition to, their existing life-saving appliances or arrangements, such
8 life-saving appliances or arrangements, in so far as is reasonable and practicable, comply with
9 the requirements of this chapter. However, if a survival craft other than an inflatable liferaft is
10 replaced without replacing its launching appliance, or vice versa, the survival craft or launching
11 appliance may be of the same type as that replaced.

12 In 1993, while *El Faro* was named *Northern Lights* and before it was lengthened, the Coast Guard
13 officer in charge of marine inspection in Mobile, Alabama, advised, “All modifications to the vessel must
14 comply with the most recent SOLAS amendments,” and further, “As a practical matter, all aspects of the
15 vessel not being modified may remain as is, but whenever equipment, such as lifeboats, need replacement
16 they must meet the most recent standards.”⁶⁸ In 2002, the Commanding Officer of the Coast Guard Marine
17 Safety Center advised, “When an alteration constitutes a major conversion, it is appropriate to bring the
18 entire vessel into compliance with the latest safety standards where it is both reasonable and practicable
19 to do so.”⁶⁹ However, in 2004, after TOTE objected to the treatment of the conversion as a “major

⁶⁸ *M/V Northern Lights*, O.N. 561732, Sun Shipbuilding Hull 670, 733.75' x 92' x 60' Ro/Ro Trailer Carrier Lengthening by 90.75', letter from Coast Guard Officer-in-Charge of Marine Inspection, Mobile, Alabama, to Atlantic Marine, Inc., November 20, 1992.

⁶⁹ *Great Land*, *Westward Venture*, and *Northern Lights*, 736.8' x 92' x 4', Ro/Ro Container Vessel (I/SOLAS), Major Conversion Determination, letter from Coast Guard Commanding Officer, Marine Safety Center, to Garvey, Schubert & Barer, February 20, 2002.

conversion” as defined by Title 46 *United States Code* §2101(14a), the commanding officer of the Coast Guard Marine Safety Center “overturned the original determination” and advised that “to modify the subject vessels to accommodate a greater proportion of containers is not here treated as a major conversion.”⁷⁰

5.18. SAR Study: Leeway of Open Boat and Liferafts in Heavy Weather

The US and Canadian Coast Guards conducted a series of joint studies called Improvement of Search and Rescue Capabilities. The results of one study were published as *The Leeway of an Open Boat and Three Life Rafts in Heavy Weather*⁷¹ and were used to design the drift models in the SAROPs program described earlier. The test was a field test of the leeway⁷² of three SAR craft conducted in November and December 1995 in the Grand Banks of Newfoundland, Canada. The SAR craft included a 5.5-meter (18-foot) wooden plank open boat common to the Newfoundland area and two versions of a 6-person liferaft. The report also reanalyzed the capsized leeway data for a 4-person liferaft collected during a previous experiment. The results showed the leeway rates of three liferafts and a small boat after swamping or capsizing were 40 to 47 percent of the leeway rate for the same craft in standard configurations, representing a significant reduction in the leeway speed of each of the search targets. Originally, three open wooden-planked boats were outfitted for the leeway study, but only one was recovered. The other two boats were assumed to have sunk.

⁷⁰ *Great Land, Westward Venture, and Northern Lights*, Ro/Ro container vessels, Reconsideration of Major Conversion Determination, letter from Coast Guard Commanding Officer, Marine Safety Center, to Totem Ocean Trailer Express, Inc., November 8, 2004.

⁷¹ Arthur A. Allen, US Coast Guard, and Reginald B. Fitzgerald, Oceans Limited, *The Leeway of an Open Boat and Three Life Rafts in Heavy Weather*, Report No. CG-D-03-98 (US Department of Transportation, US Coast Guard, Washington, DC: September 1997).

⁷² Leeway was defined in the National SAR Manual as “movement of a craft through the water caused by wind acting on the exposed surface of the craft.” Fitzgerald et al. (1993) proposed a revised leeway definition: “Leeway is the velocity vector of a SAR object relative to the downwind direction of the search object as it moves relative to the surface current caused by wind and waves.”

A result of the study was the prediction of swamping and capsizing events. The current SAR manual guidance is to use the leeway equations provided for wind up to 40 knots (20.5 meters per second) to predict the leeway of liferafts and other craft. In heavy weather, liferafts and small boats may swamp, capsize, or sink, and the leeway equations would greatly overestimate the drift of those survivor craft that swamp or capsize. The report states that for search planning, capsizing and swamping are not a simple function of wind speed or wave height, and that more studies are required to determine which environmental factors or combinations of factors directly affect liferaft and small craft stability and seaworthiness to accurately predict when a SAR craft changes from a standard configuration leeway target to a swamped or capsized leeway target.⁷³

The test conditions (Table 13) were less severe than those *El Faro* faced. The open boats and liferafts used in the test, which approximated *El Faro*'s survival craft, all swamped, capsized, or sank.⁷⁴

Table 13. Swamping, capsizing, and sinking events in US-Canada leeway study, 1992, 1993, and 1995.

Craft	Leeway Run No.	Time of Event (UTC)	Hours After Deployment	10m Winds ^a m/s (kts)	Wave Height m (ft.)
4-person liferaft	22	0700 6 Dec 92	81	17.2 (33.4)	4.3 (14.1)
4-person liferaft	25	0010 13 Dec 92	57	13 (25.2)	5 (16.4)
46-person aircraft slide raft	51	0820 11 Dec 93	15	8 (15.6)	3 – 3.5 (9.8-11.5)
1-person liferaft	54	2100 16 Dec 93	27	15 (29.2)	5 – 6 (16.4-19.7)
5.5 m open boat #1	60	2250 28 Nov 95	56	16.2 (31.5)	3.4 – 3.9 (11.2-12.8)
5.2 m open boat #2	61	Nov 95	Unknown	N/A	N/A
5m open boat #3	62	After 1451 30 Nov 95	>115	7.5 (14.6)	4.5 (14.8)

⁷³ Allen and Fitzgerald, p. iii, pp. ES-1 to ES-4, 1-1, 2-6, and 5-1 to 5-12.

⁷⁴ Oceanographer of the Coast Guard interview transcript and errata, NTSB-Coast Guard, March 3, 2016.

6-person liferaft Full ballast bags	63	2230 28 Nov 95	55.5	16.1 (31.3)	3.5 (11.5)
6-person liferaft Small ballast bags	64	1850 2 Dec 95	47.5	16.7 (32.5)	5.6 – 5.9 (18.4-19.4)

1 ^a10-meter winds are the surface winds that are reported and provided by the world's meteorological models.